COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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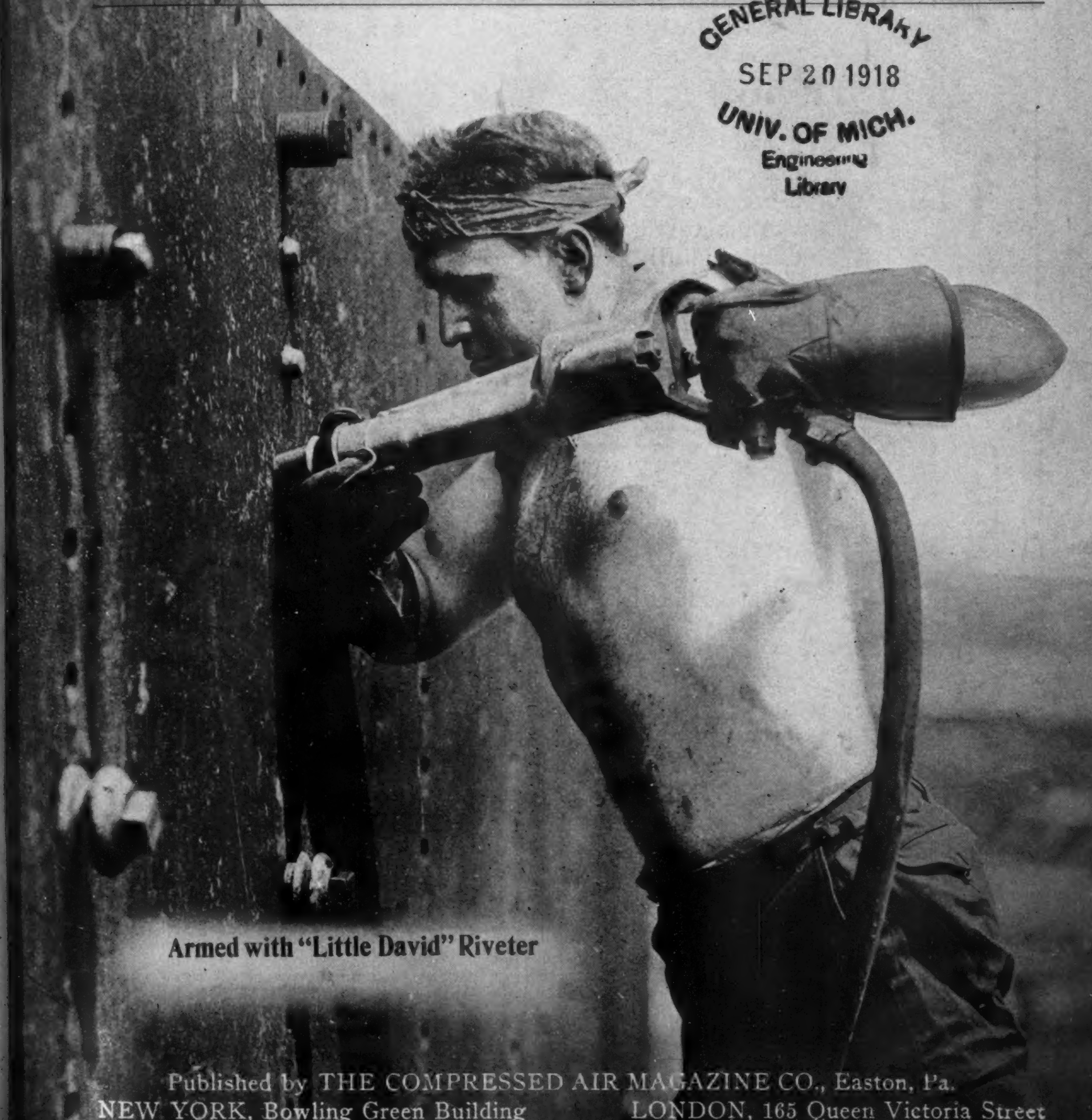

Armed with "Little David" Riveter

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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COMPRESSED AIR TO WIN THE WAR

By Frank Richards

When the great world war shall have been won it will not be easy to prove that it was won by compressed air, but it is easy enough to demonstrate upon the spot, and before we leave this printed sheet that the war cannot be won without it, which should go far toward proving the whole.

Few can realize how dependent are our modern activities, whether in peace or in war, upon the aid of compressed air, perhaps not so much directly as indirectly, but just as truly in either case. It would be a good thing for all hands to know a little more about how compressed air got under way, how it acquired its momentum, and the gait it is now traveling. A little looking into the history of compressed air in its modern uses and adaptations, what it has done and what it is doing, should stiffen our faith in its power of accomplishment, and its history is one of the shortest.

The career of compressed air as we are now indebted to it begins with the rock drill as its principal dependent, although not one-tenth of the air compressed in these days goes to the driving of rock drills, but the rock drill still suggests the easiest way of getting acquainted.

In all great engineering undertakings, such as the building of canals and railroads, and especially the construction of great aqueducts either for water power transmission or for municipal water supply, there is always involved the cutting and removal of masses of rock, this up to as late as the middle of the nineteenth century, having all to be done by hand drilling, with black powder for the blasting.

Now, rock drilling by hand, one man holding a chisel or bit and occasionally lifting it and turning it a little, with two men striking it with sledges, is a slow and tedious process, and, moreover, prohibitively costly beyond narrow limits, so that engineering works before the coming of the air driven rock drill were located so as to avoid rock cutting as much as possible, and were planned and laid out quiet differently from the lines that would be followed in these days.

This same handicap gave many crooks and twists and miles of them unavoidable length to the earlier railroads, some of which have since been straightened and shortened by, we might say, the air driven rock drill. The Boston and Albany, one of the earlier American railroads, was built under the primitive conditions. It followed the tortuous windings of the streams and climbed the steep hills of Western Massachusetts. Its phenomenal prosperity led to the planning of a competing road with straighter lines and easier grades, but—and a big but it was in those days—with the Hoosac Tunnel to bore.

This Hoosac tunnel proposition must have been more or less a trusting to luck, for the means of driving a 4¾ mile tunnel through hard rock were not then in sight.

Hand drilling was started on the job, and the so-called tunneling machines of optimistic inventors demonstrated their failures. The delay and the apparent hopelessness of the task became a by-word, so that the dear old Autocrat of the Breakfast Table, in his "Latter Day Warnings," could write:

When the first locomotive's wheel
Rolls through the Hoosac tunnel bore
* * * * * * * * * *
Then order your ascension robe.

THE ROCK DRILL ARRIVES

But then along came the air-driven rock drill, so well thought out and worked up that with little preliminary experimenting or adjusting it was an immediate success. It began to walk right into the rock at once, and when it got fully under way, with the other arrangements co-operating, the tunnel was driven to completion. The tunnel at once advertised compressed air and the rock drill all over the world. Europe soon so developed the tunnel habit that the time records for tunnel driving have kept on the other side of the Atlantic ever since.

Besides the Hoosac tunnel, and the endless string of other tunnels which had been unknowingly waiting the coming of the rock drill, there was next the entire mining field. Mining, as we know, is entirely a rock cutting proposition, and the rock drill at once and completely "filled the long felt want."

The air-driven rock drill now completely dominates this field, so that it is the simplest statement of fact to say that not only our silver and gold but also all the baser metals—except a pile of iron ore that they dig with a shovel—are obtained by the persistent activity of the rock drill.

CAN'T LIVE OR FIGHT WITHOUT IT

So, then, when we can live and when we can carry on war without coal and copper and iron, without lead and zinc—not mentioning silver and gold—and all the things the rocks hold for us, then, and not until then, can we do what we will without compressed air; and there is the proposition with which we set out completely established.

But that is only the beginning of the story, and it would not be fair to compressed air, or to those who ought to know about it, to leave it there.

THE APPRENTICE DAYS OF COMPRESSED AIR

The history of the water supply of New York city is interestingly connected in various ways with the history of the rock drill and the development of compressed air practice. The first Croton aqueduct, completed in 1842, had no help in its building from the air driven rock drill, and consequently on its entire line which traversed the surface of the ground as much as possible—taking seven or eight additional miles of length to do it—the number of short tunnels which were unavoidable aggregated only 4 per cent of the entire length. To carry the water over the Harlem River at nearly hydraulic grade High Bridge was built, the finest example of all stone construction the metropolis can boast.

THE "NEW" CROTON AQUEDUCT

When the New Croton aqueduct was built—1885 to 1890 for the actual building of it—the rock drill had come into its own and was ready to tackle anything, even the 33 miles of continuous tunnel proposed, the longest tunnel even thought of up to that time, so the new water tube was carried deep down in the solid rock all the way; and to pass the Harlem there was no high bridge, but a siphon went down 300 feet below the river and up again on the other side.

A TUNNELING SCHOOL

Although the air driven rock drill had already proved itself a great success, and was busily employed in all the great mines, the limits of its capabilities were as yet unknown, and the details of practice for its most profitable employment were yet to be determined, and probably no better opportunity for anything of like importance ever occurred. So that the work might be carried along as fast as possible there were 40 shafts, giving 80 faces of rock to work against, and the several sections were let to competing contractors, all striving to surpass each other and especially to realize the greatest profit. Here was a practical rock cutting and tunneling school for the whole world. It may be well to note a few, and only a few, of the things there was a chance of learning.

Rock drills when working in the open have frequently been driven by steam, but in mining and tunneling steam is too much of a nuisance and cannot be tolerated and air takes its place. The job of the air compressor, therefore, would seem to be extremely simple. It is only to pump or compress a sufficient quantity of air and to keep the pressure high enough.

LEARNING ABOUT AIR COMPRESSION

But there proved to be much to learn about the compressors as well as about the drills. When you compress air it gets very hot. If it is at average atmosphere temperature, say

60 degrees, when you begin to compress it, the temperature will be 432 degrees after compressing the air to say, 80 pounds, which is what the drillers call for. This means that its temperature will have been raised by an amount equal to about twice the difference between the freezing point and the boiling point of water. Then if you are liberal in the use of oil for the machine, which, being interpreted, means extravagantly wasteful of it, not a drop of oil will be destroyed or disappear but will be carried along by the compressed air and be deposited in the air receiver, and the hot air will be quite apt to set it on fire. On this aqueduct work air receivers sometimes got red hot, actually and visibly red, from the fire inside.

The air, although made so hot by the compression, would, unless the oil took fire, cool very rapidly as it flowed along in the pipe, so that generally when it reached the drill the excess of heat would be all gone, and then the air as it expanded in doing its work in the drill would become intensely cold, and the moisture which is always present in the air, would freeze and accumulate in the passages of the drill and choke them up, so that the drill would not work until it could be thawed out. Experiences of this character led to improvements in air compressors and in compressed air practice, and the machines became gradually standardized, efficiently reliable, and ready for the great tasks before them.

The drills on the job also went through their course of training and were tried out in all their details. The size and power best adapted to the work were to be proved, the best materials for their construction, the reliability of their operating mechanism, rapidity of wear, ease and quickness of repair, facility of setting up, pulling down and moving about. Absolute duplication of parts began to be insisted upon and standardization became more and more complete.

Another exacting lesson had to do with the bits or steels which actually did the rock cutting, as to the most reliable brands of steel and methods of forging, hardening and tempering, the most effective shape for the bit, the number of cutting points, the acuteness or bluntness of the angles.

But however effective may be the drills, success must ultimately depend upon the actual drilling and the blasting. The number and location of the holes for the face of rock attacked are to be determined, the proper diameter of the holes, their depth and the angle at which they shall be drilled.

Then in the blasting also there is a carefully planned system to be followed, as to the kind of explosive to be used, the sizes of the cartridges, the order in which the holes are to be fired, as not all are exploded at the same instant. In tunnel work it is generally arranged that not the entire tunnel section is worked at once or with one gang of men. A certain portion, a heading, sometimes at the top and sometimes at the bottom, being driven a considerable distance in advance of the rest. Then at the same time another gang may be working at the remaining portion. This not only carries the entire work along so much faster, but it provides better for the getting away of the muck. To time and arrange all the operations so that they will interfere as little as possible with each other, and so that all may have sufficient time for their specific work is no simple task. In all the particulars suggested the second Croton aqueduct was a worker-out of many problems whose solutions were greatly to the advantage of the succeeding generations of engineers.

THE DIFFERENT LESSONS OF THE THREE AQUEDUCTS

The three successive aqueducts built for the water supply of New York, although not very far apart in point of time, mark three distinct periods in engineering practice.

The first Croton aqueduct was an example of the engineering practice of the olden times. It was built entirely without the aid of compressed air, so we have no more to do with it in this connection.

The second or the "New" Croton aqueduct was, as we have seen, indebted entirely to compressed air for its existence, but it was after all, at least in one respect, a rather crude construction. No attempt was made in the tunnel as a whole to have it perfectly water tight. The interior surfaces of the rock excavation were allowed to remain just as the explosives had left them. On the completion of the tunnel, in testing it for leakage, it was found in a certain portion of the tunnel that the leakage of water out of the tunnel amounted to a million gallons a day; but it was also found that in another part of the tunnel, where the ground was high above it, there was a leak-

age of water *into* the tunnel amounting to two million gallons a day, so there was little occasion to worry about that.

THE CONCRETE AGE

Before the construction of the Catskill aqueduct the Concrete Age of engineering had begun, and this aqueduct, while fully indebted to compressed air for its being, has also concrete as an essential and conspicuous element in its construction. This aqueduct, with a total length of 120 miles, and with its main sectional area greater than that of both of its predecessors, required under its various contractors 65 large air compressors, never all in service at once, with an aggregate capacity of 100,000 cubic feet of free air per minute, one of the compressor installations being at the time the largest in the world. The compressed air in this aqueduct work was employed, besides for the driving of rock drills, in such a variety of ways that it is not easy to enumerate them. There was the pneumatic conveying and depositing of large masses of concrete and also the thin laying and building up of concrete over large surfaces by the cement gun. The air lift was used for unwatering a shaft and other purposes. The pneumatic caisson was employed for shaft sinking, and men worked in air pressure in driving the tunnel under a swamp. Then pneumatic drilling, riveting and calking tools were called for where steel tube construction occurred.

BARGE CANAL

In the building of the New York State Barge Canal it might have been expected, as it was entirely an out of doors job, that steam would have been employed throughout, and that compressed air would have had no chance at all. But air did have a chance here also and showed another phase of its adaptability. Advantage was taken of available electric current, generated by water power and transmitted considerable distance, to drive air compressors located near the work. The compressed air thus produced took the place of steam entirely at many points and did all the work of steam, operating rock drills, rock crushers, hoists, conveyors, pumps, and doing the work more cheaply, or it would not have been employed.

Some special work which only compressed air could have done came along incidentally. For instance, in one case it was found that there was a serious leak, due to a stratum of defective rock, under the walls of a lock after its completion. To cure this leak a tunnel was driven, in regular subaqueous, pneumatic tunneling style, under the walls and end of the lock, thus removing the defective portion of rock, and then the tunnel was entirely filled with concrete, and the leak was stopped.

PANAMA CANAL

While we are on the big jobs it is only proper to mention briefly the Panama Canal. Here compressed air found its opportunity again and did effective work. Along the Culebra Cut twelve large air compressors were installed in three about equidistant points connected by 14 miles of air mains with 34 miles of branches. These compressors, delivering 30,000 cubic feet of free air per minute, made world records for efficiency and high economy of operation. There were also compressor plants at two other points and also in the two great machine shops. The air was used for hundreds of rock drills, for deep well drills, for hoists, conveyors, rock crushers, and for the handling of the masses of concrete. In the shops there were all the variety of pneumatic tools in use.

THE BIGGEST COMPRESSED AIR MONUMENT

Following these three great achievements in modern engineering, the Catskill Aqueduct, the Barge Canal and the Panama Canal, in the construction of each of which compressed air bore a part so conspicuous and responsible, we came to another work vastly greater than either of these—and it is not finished yet—New York City itself. In its upbuilding in the last twenty-five years is surely the greatest of all the works of compressed air and its most impressing monument.

New York is builded upon a rock, and of late years compressed air has had the preparing of the foundations for its responsible erections. The New York Central and the Pennsylvania Stations required the excavation of enormous masses of rock, and the miles and miles of subway—the length increasing with the date—mostly cut in the solid rock, were the work of air driven drills.

Downtown, where the world famed skyscrapers are massed, the top of the primeval rock is far below tide level, and to secure sure support for the great structures pneumatic caissons are sunk to the rock surface, the men working in the caissons under the air pressure required to exclude the water, removing the

superincumbent earth within as the caisson descends.

Then the driving of the several tunnels under the North and the East Rivers was entirely a compressed air job, the sand hogs here having practically continuous employment for many years past and for countless years to come. In this work two styles of air compressors are required, the one supplying air at comparatively low pressure to oppose the pressure of the water, this air being the atmosphere in which the sand hogs work, and the other delivering high pressure air for driving the rock drills and other pneumatic tools as required.

Compressed air, again, has rendered important service in New York harbor improvement, especially for subaqueous excavation at Hell Gate and elsewhere, work which promises to be greatly increased in the near future. In our enumeration we must not forget the compressed air work in preparing the foundations for the piers of the great East River bridges, including Hell Gate bridge. Besides all this are to be remembered also the great numbers of smaller pneumatic tools, hammers, drills, riveters employed in the erection of all the structured steel work occurring in all the undertakings above spoken of.

It is not necessary to offer here any figures in corroboration. In time, in labor, in money, in responsibility and effectiveness, compressed air has massed its greatest achievements in and immediately around New York, with a perpetual contract ahead. In mentioning the various services of compressed air in the upbuilding of the great city we cannot forget that the three aqueducts are part and parcel of it.

Compressed air at the same time knows neither time nor place; for wherever things are being done it is sure of its share in the work. The distribution of the air compressor's sent out by the various builders is a sufficient voucher for this, not one per cent of the machines in use being located within sight of New York.

But enough of this. It is more than sufficient to show that wherever on earth big things are being done compressed air has a hand in them, and we may be sure enough that in the biggest thing in all earth's history, the great world war, compressed air must be there in force, as we shall not fail to see.

To be concluded.

FIG. I

THE COMPRESSED AIR EQUIPMENT AT HOG ISLAND

By B. K. Price

For expediting the construction of ships at Hog Island extensive use of compressed air was recognized as a vital factor, and considerable attention was given to this phase of the work in planning the huge yard. As a result there is at Hog Island to day the second largest compressed air plant in the world, planned and built under the supervision of several of the country's most eminent engineers.

The plant was planned to supply compressed air at 100 pounds working pressure. It comprises five separate air compressor units which supply the shipways and shops, and two smaller units which supply the marginal wharf. By dividing the air compressing capacity of the yard into units and inserting valves in a main pipe running along the heads of the slips and wet basins the danger of a shut down of the entire air system is practically eliminated. The five larger compressor units are located at about the center of each of the five groups of

10 ways, while the two remaining units are along the marginal wharf, each serving half of the total number of eight wet basins. These various compressor houses also serve as high voltage substations.

Leading from each of the compressor houses along the shipways is a 12-inch pipe through which the air is fed into a 10-inch main, extending parallel to and 98 feet from the heads of the slips for more than a mile. This main distributes the air into 6-inch pipes, one of which runs on each side of the keel blocks in each slip. A tee and manifold with six outlet valves is inserted in these pipes at 20 foot intervals along the length of the keel. Another main, 6 inches in diameter and connected to the larger one, extends along the marginal wharf, a distance of over half a mile, and 3 inch branches are taken down on each side of the wet basin piers. Outlets similar to those on the building slips are inserted in these branches. Provision for expansion and inspection is made by the introduction of U bends and the use of box trenches along the main lines.

Compressed air is also used extensively by the shop group, and it is supplied by tapping the 10-inch main and leading a 6-inch branch back and across the front of the group, where suitable extensions are made to each shop.

DESCRIPTION OF EQUIPMENT

The five larger units are of identical type and each is equipped with three Ingersoll-Rand air compressors. Two of these compressors are 40 and 25½x30 inches, direct connected to a 1020-horsepower, General Electric 400-volt, 3-phase, 60-cycle synchronous motor, having a speed of 138½ revolutions per minute. The actual delivered capacity of each is 5320 cubic feet of free air per minute. The third compressor is 28 and 17½x21 inches, direct connected to a 450-horsepower, General Electric 4000-volt, 3-phase, 60-cycle synchonous motor, having a speed of 180 revolutions per minute. The actual delivery capacity of this unit is 2,275 cubic feet, making the total capacity of the plant 12,915 cubic feet of free air per minute.

DRYING THE AIR

Some of the difficulties not infrequently arising in the operation of air tools are due to the moisture in the air. This moisture on being

FIG. 2

FIG. 3

carried into the machines tends to wash away the lubricant and to increase the wear by leaving bare rubbing surfaces in contact. It also condenses and collects in the pipe lines, interfering with the free passage of the air, and may freeze and choke the pipes in cold weather. This disadvantage is particularly serious when the work is in the open.

To eliminate it each of the compressors has been equipped with an after cooler and separator which serves to remove the moisture from the air before it enters the distribution system. This is accomplished by cooling the air to a point at which the moisture will condense and accumulate in suitable receptacles to be drained at intervals. The after-coolers serving the two large compressors in each plant along the ways have a cooling surface of approximately 1005 square feet, and the one serving the smaller compressor 505 feet.

Intake air is drawn from the outside through cast iron or salt-glazed pipe cast in the concrete foundations and terminating in sheet metal cowls 12 or 13 feet above the ground. A suitable piping system is installed for leading the discharge air from the compressors to a receiver which acts as a separator and serves to dampen pulsations for the complete unit. Cooling water for the compressor jackets, inter-coolers and after-coolers, is supplied by a system of water pipes which later discharge the water into the Delaware river, along which the yard is located.

Indicating and recording thermometers and pressure gages are installed in the pipes. An air-flow meter is also to be installed in the 12-

inch discharge line leading from each compressor plant, between the receiver and the 10-inch air main.

The two plants which feed into the 6-inch main at the head of the wet basins are similar to the others except they contain only two of the smaller compressors, making the total capacity of each plant 4,550 cubic feet of air per minute. This makes the entire compressor capacity of the yard 73,675 cubic feet per minute. Maintenance of the compressors is facilitated by a 10-ton, hand-operated traveling crane. For storage and operating maintenance of the air tools used on the ways, an air tool house has been built at the head of each group of five building slips. These buildings are equipped with grinding and lubricating machinery and storage racks.

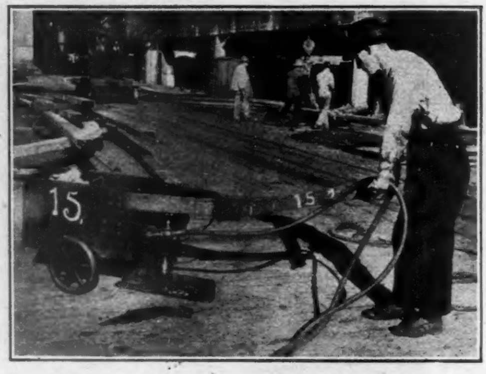
GREAT NUMBER OF TOOLS USED

An idea of the volume of compressed air required in building the ships may be obtained from the following list of pneumatic tools in use: 1675 riveters of one size and 100 of another; 1325 holders-on; 200 jam riveters of one size and 480 of another; 450 nonreversing pneumatic drills; 200 corner drills; 150 breast drills; 100 chipping and caulking hammers of one size and 1250 and 500 of other sizes respectively; and 50 grinders. Eight hundred rivet heating forges are to operate from compressed air lines. Equipment necessary to the operation of the pneumatic tools includes about 300,000 feet of rubber hose, 6500 sets of pneumatic hose couplings, 150 bottom riveter frames, 12,000 chisel blanks and 15,000 rivet sets.—*Marine Review.*

PORTABLE MOUNTING FOR PNEUMATIC DRILL

By H. H. Hicks

The accompanying illustrations show how a "Little David" drill, No. 1-B, has been rigged up by the Hanlon Drydock and Shipbuilding Company, Oakland, California, for service as a portable countersinking machine. The drill has been fastened to two metal supports bolted to the sides of an iron box 16 inches wide, 24 inches long and 16 inches high, provided with a suitable stop for the feed screw. The rig is fitted with a 6-foot handle and mounted on two wheels. Sufficient weight is placed on the box to give the outfit proper stability when in operation. An air hose is connected and a valve placed in the line for



PORTABLE MOUNTING FOR LITTLE DAVID

use instead of the usual drill throttle. A second hose is provided to feed water for cooling the countersink. Mr. Hiefield, the superintendent, is authority for the statement that this rig will do from 75 to 100 percent. more work than the stationary wall countersinkers.

An outfit of this kind can be easily constructed in any shop and represents but a moderate investment. A suggested modification is that the box be partitioned through the center and that counterweights be carried in the compartment farthest from the drill; and the other half of the box be used as a tank to carry water for cooling the countersink. This would obviate the necessity of double hose connections.

EFFECTIVENESS OF MUSTARD GAS SHELL

The recent announcement that the Allies now have an effective supply of mustard gas shell shows how vital the chemist's work is to modern warfare. The gas shell has been one of the biggest problems for the American chemist, especially for those connected with the Chemical Warfare Service of the National Army. That the problem has been well solved is attested by documents found on captured Germans during the great drive now in progress. These documents state: "This gas (mustard gas) seems to have, even in diluted form, more harmful effects than the gas contained up to the present time in shells used by the field artillery."

Mustard gas, now being used extensively by both the Central and Entente powers, is a compound chemically known as dichlorethyl sulfide. In trench language it is called "mustard" because of its strong pungent odor, and

to the Germans it is officially known as Yellow Cross gas, as the shells are all marked with yellow crosses and bands. The Allied chemists have known the composition of this gas for some time, but only recently have they been able to perfect a process for manufacturing it on a large scale. Fortunately for our armies, this method is far superior to methods known hitherto.

Although the effects from this gas are not often deadly, still it is a very effective agent on account of its slow and insidious method of poisoning. The odor of mustard indicates danger, but is not in itself uncomfortable until it causes the nose and throat to become irritated. If properly protected, there will be no further bad effects. In extreme cases the eyes and lids become inflamed and blistered and severe inflammation in the lungs results in bronchitis and even pneumonia. The after-effects of the poisoning lays one up for several weeks, but seldom results in death.

The most disagreeable thing about the gas is its persistence, which necessitates keeping on gas masks for hours at a time. It lingers in dugouts for days, and has to be forced out by means of fires and fans. In this connection, the captured German documents state, "gas poisoning still occurred among those who took off their masks after wearing them for 12 hours."

HIGH FLYING EXPERIENCES

By Captain B. C. Hucks

The most marked development in the modern machine is its extraordinary capacity for climbing to a great height in a short time. At the beginning of the war the average height flown on active service was 4,000-5,000 feet, simply because few of the machines then in use with the impediments carried could get much higher. Today a height of 20,000 feet is, I believe, on certain occasions reached, and it is fairly certain that if progress continues at its present rate, heights a great deal beyond this figure will be reached as a usual thing. These great altitudes bring forward many difficulties which will have to be seriously considered. The first trouble in the winter will be the extreme cold to which the occupants will be subjected unless they are protected by special cowling. This, to a certain extent, is the natural advantage obtained in the tractor. The question of the difference in the comfort of machines in this respect was shown to me in a very marked manner last winter. I was testing the fall-off of engine power at a height on a tractor two-seater in which it was specially arranged that the warm air from the radiator and engine passed along the fuselage to the pilot and then to the passenger, and although at a height of over 21,000 feet with the thermometer below freezing at ground level, I did not suffer in the least from the cold, neither did my passenger who sat behind complain until we shut off to descend. As a contrast to this, a few days later I was on a single-seater scout at an altitude of 17,000 feet, and although it was a tractor with a rotary motor, I suffered intensely from the cold, and became so numbed that my vitality must have been something akin to a dormouse under the snow, and, in spite of being well gloved, I had frostbitten finger tips which pained for many days afterwards. Surely this is a very inefficient state for a pilot at the front to have to take on an air fight or other exacting work? Put two pilots up to a great altitude, one kept well warmed and comfortable, the other half dead with the cold and it would be easy to surmise which would be most likely to do the best work.

I really believe it is more by accident than design that the pilot or passenger has benefited at all in the past from the heat of the engine, with the exception perhaps of the late S. F. Cody's machine. He purposely placed the radiator of his pusher in front of the pilot to keep him warm. I know from my experience when flying in France in the cold weather that the discomfort owing to the extreme cold became intense when flying only at 6,000 feet on a two or three hours' reconnaissance flight. This is a point to which designers should give attention, as machines are now capable of reaching great heights.

Cold also affects the motor pretty seriously. This is more noticeable with the water-cooled type. Unless some provision is made for blanketing the radiator surface at heights, it becomes far too cold for efficient running. Cases are known of the freezing of the water system on a descent from a great height, with pretty serious results to the motor, as well as the difficulty of getting the engine to run again efficiently through being too cold to effect a landing. In the future war machine the pilot must have a very wide range of control over the water-cooling system.

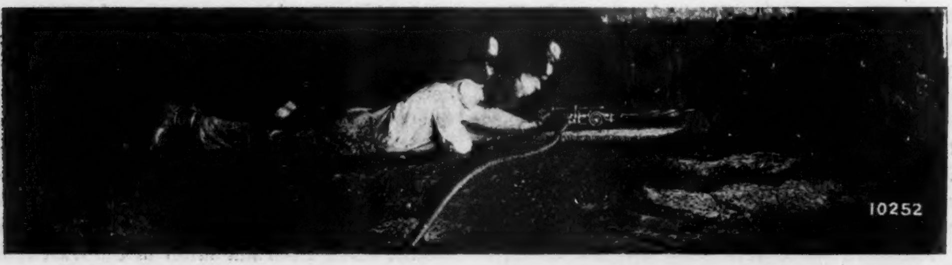


FIG. 1

MECHANICAL EQUIPMENT AND THE CONSERVATION OF MINERS

By R. L. Herrick, E. M.

Mine-labor shortage is in these days the bugaboo of the anthracite district. Recent drafts to the army have aggravated an already bad labor condition. Before the draft many mines were running with mine crews depleted from 15 to 40 per cent. from those of normal pre-war times, and now the production of anthracite threatens to ebb to a new low mark. The mining situation presents a curious discrepancy, however, that may well be noted. It is this: While the loss of many men has adversely affected the production of some of the largest and oldest mines of the district, others with similarly reduced mining crews have actually increased their tonnage. Investigation into the causes of this discrepancy has led to the conclusion that the gain or loss of tonnage is largely a question of mechanical equipment. Those mines which have held their tonnage output to about normal—or if anything have increased it—have installed modern machinery equipment which has conserved the man-power of the organization. Instances are common where the installation of certain machines has made what was formerly heavy labor now easy on the men, and at the same time allowed one or two of them to do the work formerly requiring the united efforts of from six to eight. It is, of course, understood that the men thus released from routine work have been immediately transferred to the vitally important work of getting out coal.

In what follows it is proposed to give typical examples of such man-power saving as were observed in the course of a 450 mile automobile trip about the mines in various parts of the anthracite district. An engineer intimately acquainted with the district through long residence, Mr. William Wilhelm, Scranton manager of the Ingersoll-Rand Company, is sufficient authority for the accuracy of the statements here made.

To what extent will it pay to replace hand with machine drilling? The anthracite operator is squarely face to face with this issue today. And upon his answer to that question largely depends the amount of man-power conservation he will be able to effect. In general terms it may be stated that coal is ordinarily machine-drilled in say from one-fifth to one-sixth the time that the same holes can be put in by hand. The hardness, dampness and physical properties of the coal vary widely in different parts of the anthracite district, and all of these conditions affect the speed of drilling. Thus in some sections the hand drilling of a 6-ft. hole requires say 10 min., while in others it cannot be done in less than 30 min. In general, therefore, the same holes will require only say 2 to 6 min. when drilled by machine.

On the face of the situation thus presented

FIG. 2

FIG. 3

there could be no question about the advisability of universally adopting machine drilling. But actually there are a number of other considerations which influence the operator. Perhaps one of the elements most vitally affecting the problem is the fact that in most of the large operations the miner is practically a free agent. He is paid by the ton of coal, or yard of advance in rock, and his hours of work are advised, but not dictated, by the mining companies. In addition to this, the miner owns his own tools, although he may be financed by the operator to enable their purchase.

Under such conditions it is only natural to expect that machine drilling of coal is in vogue only where the mining conditions themselves caused the miner to employ drills in order to make, what are to him, satisfactory wages without a great deal of unnecessary hard work and in a satisfactory number of hours of labor.

So far mining conditions have made immediately advisable the adoption of machine drilling only in thin beds of comparatively small pitch. War conditions such as high price, etc., have enabled the working of such beds at a profit. Hence, in thin measures we find machine drilling of coal naturally making its first big progress of supplanting hand drilling. This is not meant to imply that in thick beds progress with machine drills has not been large, but only that this progress has been comparatively greater in thin beds. Some of the reasons for this condition are made plain by contrasting Figs. 1 and 2, showing thin-seam mining, with Figs. 3 and 4, which illustrate conditions in much thicker beds of coal. Fig. 1 shows the drilling of a bottom hole in an anthracite bed which is only 20 to 24 in. thick. In this case a plank is used on which the Jackhamer is slid along. Fig. 2 shows another view in this same bed, using a JC-40 drill mounting. The bottom of this bed consists of 6-in. of bone and is consequently exceedingly hard to drill.

Such beds as this were practically impossible certainly unprofitable, to mine with the old hand-auger drilling method, but have been made profitable with machine-drill methods which produce a good tonnage per day.

Fig. 3 shows the drilling of a horizontal hole in the Dunmore vein, which, as plainly shown, consists of alternating bands of coal, bone and slate, making up a total thickness of about 6 ft. Such a bed is hard to drill by hand, and hence the favor shown to machine drills.

An example will suffice to still further clarify the situation: A coal bed 30 in. thick is mined in the Scranton district by rooms 30 ft. wide. The coal face is attacked by say from 11 to 14 holes, drilled about 6 ft. deep, which should blast down 450 cu.ft. of material, netting say 16 tons of coal.

The hand-auger drilling of these holes will require an average of say 30 min. to the hole, thus requiring 6 or 7 hours of labor. The machine drilling of these holes will take only from 55 to 70 min. to complete, although these are by no means the quickest figures on record.

Figs. 1 to 3 all show the use of twisted cruciform steel in connection with the Jackhamers. These machines differ in no way from the standard drill striking a hammer blow, but the use of twisted steel allows the standard drill rotation to produce an auger-like effect in the holes, thus rapidly clearing them of pulverized coal (clearly shown in Figs. 1 and 2 beneath the steel).

The use of this cruciform steel has rapidly grown in favor, especially during the past year in the Scranton district. It was originally furnished by the manufacturer in sizes to accommodate the usual diameter of black powder cartridges. But in response to the demand for hand-drill outfits in other districts, where Monobel powder is in use, another size of twisted steel is being manufactured and will soon be available.

For the mining of thin coal beds the drill mounting shown in Fig. 2 has proved a boon to the miner. In fact its lightness enables quick movement from place to place, while its operating features reduce the miner's drilling job to a sinecure. He has only to push the drill straight ahead, and it practically runs itself.

Aside from being easier than hand-holding upon the drill operator, the mounting performs the double function of providing a steadyrest in starting and pointing the hole, and that of furnishing a support during the drilling. Without such a support the average miner lets the drill practically hang upon the drill steel after the latter has advanced 6 or 8 in. into the coal. The support afforded by the mounting has been found to practically eliminate drill steel breakage arising from this cause.

While machine drilling of coal is apparently most common in the thin beds, and in those thick ones whose bone and slate layers make hard hand drilling, it has a great future in the thick and easily hand-drilled seams. War-time conditions seem certain to hasten the coming of that future.

The visitor to the various mines of the anthracite district is somewhat puzzled to account for the facts as he sees them. For instance, in many thick and easily mined beds he finds the Jackhamer busy, as shown in Fig. 4 taking up the rock bottom. For rockwork nearly every mine in the district has such machines by the score. But when it comes time to mine the coal, the miner picks up his hand auger and goes at it. This may not be the rule but the writer saw it often enough throughout this district to be impressed by its frequency.

For example, in the case of the mine shown by Fig. 4 the coal bed was 8 ft. thick, had a high pitch, and the coal itself was comparatively soft. The miner could drill his 8-ft. holes in about 10 min. each by hand auger, and could completely drill his room in about two hours. Under the present working conditions he could bring down in a few hours all the coal by hand that his one "buddy" could load in a day. Those few hours enabled him to quit about noon well satisfied with his usual day's wages.

This particular miner was not interested in the machine drilling of coal, and for obvious reasons. This illustrates the perplexing problem some mine operators face today. The present situation may, in fact, be paraphrased as this: "One miner, one auger and one buddy." Why should it not be: "One miner, one machine drill and four buddies?"

Is there any reason why the miner should not acquire greater dignity as the employer of four helpers instead of one, and make increased mining profits in proportion? Must the correction of a decreasing coal production be impeded by the old-established custom of

FIG. 4

having one buddy only? Upon the answer to these questions may hang the fate of nations!

Suffice it to say that it is believed that under changed conditions a machine-drill miner can easily replace four hand-auger men in thick beds and thereby allow the saving of three miners, thus made available for either increasing the coal output or filling the gaps in the ranks of the buddies drafted into the army. Fifty hand-machine drills installed in a mine should result in a man-power conservation equivalent to 150 miners per day.

Many of the coal-mining companies of the anthracite district have greatly increased the number of hand-machine drills employed underground during the past year. As a result, an increased burden of steel sharpening has been thrown upon the blacksmith shop.

The sharpening of hollow drill steel by hand is a comparatively slow and unsatisfactory method. In the average shop a blacksmith and helper will hand-sharpen about 35 to 40 seven-eighth-inch hexagon steels per day, depending upon their condition. And since the blacksmith must rely solely upon his eye for gaging, he usually makes a gage interval of about ¼ in. between successive steels of a drill set in order to insure against sticking. This handwork is so slow that frequently defects develop in the bit due to its cooling before it is properly shaped.

With the increased demands upon the blacksmith shop for steel sharpening, many mining companies started the installation of Leyner machine sharpeners. These have proved one of the most pronounced labor savers introduced into the district. An installation of one of these sharpeners in one of the largest shops of the Scranton region is shown by Fig. 5.

In this shop there were four forges employing four blacksmiths and four helpers.

FIG. 5

The operator of this machine did all the steel sharpening of the eight men and turned out a large amount of routine blacksmith work in addition. The seven men thus made available were badly needed at other work about the mine and were so utilized.

Aside from this labor-saving feature of the machine sharpener the bits themselves are far superior to the hand-made ones. Owing to the perfection of bits, made inevitable by the machine's gaging, it was possible to reduce the gage interval between steels to 1-16 in. instead of the ¼ in. as formerly. This results in greater drilling speed in the mine.

This machine sharpener is equipped for making the shanks on 1⅞-in. twisted cruciform steel. Besides its common work of shanking and sharpening steels, it is admirably adapted to blacksmith work of many kinds, such as making boltheads, and even drawheads for coupling mine cars. Some of the mines have fitted up these sharpeners with dies for making mine-car couplings, which work is being done with great rapidity.

In many sections of the anthracite district, particularly where the coal beds are of steep pitch, the movement of mine timbers into the upper workings presents a real problem. In such places the Little Tugger hoist serves a double purpose—that of supplying the needed tractive power and furnishing air for ventilation.

In one section of the Catherine colliery of the Trevorton Coal Co., the Lykens No. 2 vein pitches 15½ deg. and the steady movement of timbers up such a steep slope taxed the endurance of the men formerly employed on the job. A slope 250 ft. long connected two levels. Up this the timber was moved, and down it was discharged the coal extracted in the development of the upper level.

The development of four rooms and two gangways required six mine-car loads of timbers per day, and for carrying up the timbers by hand six men were formerly employed constantly.

A Little Tugger hoist was recently installed in close quarters at the head of the sheet-iron-lined timber chute. Its 5-16-in wire rope is pulled down into the lower level, where one man attaches it to the timbers on the cars. On signal, the hoist then pulls up from three to four timbers 14 ft. long and av-

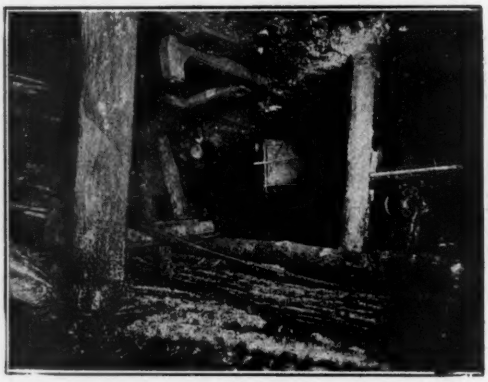


FIG. 6

eraging 8 to 10 in. in diameter. The ropeman rides the timbers to the upper level and returns with the slacked-off rope.

The timber is thus hoisted with only one man in addition to the hoist operator. These two men thus accomplish, in one-half day, the work formerly requiring six men all day. The other four men are accordingly available where badly needed for getting out coal. The hoist, therefore, performs the equivalent of eight men's work per day.

The hoist has a speed of 85 ft. per min. in lifting a maximum weight of 1000 lb. vertically, but in hauling these heavy timbers 250 ft. up the slope, about 5 to 6 min. are required for the round trip by the ropeman.

When not in use for timber hauling, this machine is available for hauling coal in a oneton buggy from the face of the level along a slight grade, to the rocker dump at the head of the chute. Fig. 6 shows the loaded buggy approaching this discharge point.

Scores of these hoists have already been installed in many mines of the anthracite district. They are used for a wide variety of purposes, such as, for instance, the hoisting of rock in buckets from shallow shafts, the hoisting of tools and men into raises, and even pulling 40-ton capacity empty coal cars up a slight grade to a loading position beneath the discharge chutes of a breaker.

At another large colliery an unusual installation of these machines shows their strength as well as adaptability. In driving a rock tunnel to connect with a shaft, it was desired to use the 108-cu.ft. capacity cars, standard about the mine, to receive the rock mucked from the face. The rock tunnel connection was about

FIG. 7

300 ft. long and had only a slight grade except at one point where for about 50 ft. the track was given a grade of 10 per cent.

The 108-cu.ft. car loaded with rock weighs about 12,000 lb., and to pull it up the 10 per cent. grade three hoists were installed, as shown in Fig. 11.

The concentration of three separate hoists pulling three ropes attached to one heavy car is, of course, rather unusual and would not often happen except in emergency cases, and then only for temporary work. This installation serves to forcibly illustrate, however, the wide adaptability of these machines, and the possibility of tiding over, with them, a situation where the delivery of a powerful single hoist under present conditions would seriously delay urgently needed mine development.

Large numbers of these little hoists are employed in the anthracite district. In each case the machine does the work formerly requiring from six to eight men. Assuming, however, that each one effects a man-power conservation of at least four men, twenty such machines effect a conservation of at least eighty men. There are a number of companies throughout the district which have installed as many machines or even more.

Activated sludge, when aid-dried, is a dark brown, friable, inoffensive material with a slightly earthy odor like that of decayed leaves. It consists largely of humus, but contains much more nitrogen, phosphoric acid and potash than does ordinary farmyard manure.

THE BEST OILS FOR AIR CYLINDERS

By W. H. Callan

A number of years ago, when the compressor business was young, considerable trouble was experienced in procuring a suitable oil for lubricating the air cylinders of compressors. After considering the matter for some time, it was decided by the company by which I was employed that an expert on the subject should be consulted. Accordingly, the matter was taken up with a well-known oil company, whose representative called upon us and, after making a careful examination of the conditions, reported that the trouble was entirely due to using an oil of too light body and too low viscosity to withstand the high heat of the compression. He stated that the oil used was gassified, due to the high temperature of the air, and that it passed off in vapor, leaving the cylinder wall without lubrication. The expert thereupon recommended an oil which he considered suitable for our use. The particular grade happened to be of 26 Beaumé gravity with a flash point of 515 deg. F., a fire test of 555 deg. F., and a viscosity of 130 S at 212 deg. F.

NO INCREASED EFFICIENCY WAS SECURED

After using this oil for some time, we found no improvement in the operation of the machine; in fact, it appeared to be laboring and the temperature of the discharge air was high. After several days of operation with this new oil, the cylinder heads were removed, the valves taken out and a careful examination made. The cylinder wall seemed to have a sticky, plastic coating; the air passages and

discharge cavity of the cylinder showed signs of dark deposits, while the faces of the valve seats were covered with a black, hard coating. This hard formation on one side of the valve seat caused the valves to leak, hence the increased temperature of the discharge air. The sticky coating on the wall of the cylinder was responsible for the increased friction.

The representative's attention was called to this condition, whereupon he suggested that a little lighter oil be used. This time he recommended one with 27½ Beaumé gravity, a flash point 450 deg. F., a burning point of 500 deg. F., and a viscosity of about 125 S at 212 deg. F. We asked him if he did not think this was a little too heavy a grade for air-cylinder lubrication. He assured us it was not, and stated that, in order to withstand the high temperature of the compressed air, it was necessary to have a rather low gravity and high viscosity oil, with a flash point above the temperature of the air.

After we had used this grade of oil for some weeks, a further examination was made; and while the cylinder wall appeared considerably better, the valve passages and discharge cavities of the cylinder were badly coated with a hard deposit. When this matter was again brought to the attention of the expert, he suggested that we reduce the amount fed into the cylinder. This was done with great care until we were only using three drops a minute in a 14x14-in. cylinder running at 150 r.p.m. But even under these conditions the deposits in the valve passages and the discharge cavities of the cylinder continued to form as long as this oil was employed.

The expert happened to come our way several months afterward, and I called his attention to the condition experienced with his oil. In regard to the amount we were feeding into this cylinder, he said this was reduced to a point that he thought was the minimum. His reason given for the formation in the passages was that the residuum of all oils is carbon, and that it therefore was no doubt due to carbon deposits. At the same time he assured us that the oil he had recommended was the best procurable for the purpose, and that we should go ahead and use it without any fear.

DEPOSIT BUILT UP RAPIDLY

This was done, but the formation in the discharge passages seemed to be building up rapidly despite the fact that only a small quantity of oil was being fed into the cylinder. These formations finally collected to such an extent that it was necessary to clean the passages in order to avoid the hazard of an explosion. The passages were accordingly cleaned, and some of the material removed was analyzed and found to contain about 1.5 per cent. free oil, 11 per cent. rust, 5 per cent. decomposed oil, 30 per cent. mineral ash, 10 per cent. coal dust, while the remainder was foreign matter, or residuum. A further investigation revealed the fact that our intake was exposed to such material as coal dust, mineral ash, shavings, water, etc., as well as some air.

After cleaning the compressor, and safeguarding the intake against dirt and dust, we procured another grade of oil which in our own judgment was more suitable for the work since in the meantime we had made investigations and studied the question to some extent. This time we procured an oil of 31 Beaumé gravity, a flash point 375 deg. F., a burning point 420 deg. F., and a viscosity of 200 S at 100 deg. F. We started by feeding three drops per minute. Finding the cylinder copiously oiled, we reduced the feed to two drops a minute. The compressor was operated in this condition for a considerable length of time with practically no trouble from carbon deposits.

Experiencing such good results from this light oil, and by this time disbelieving in many of the virtues claimed for low gravity, high flash point and heavy viscosity, we were prompted to try another grade of oil, selecting this time one having a gravity of 33 Beaumé, a flash point of 380 deg. F., a fire test of 420 deg. F., with a viscosity of 140 S at 100 deg. F. We used the same quantity as before—namely, two drops per minute in a 14x 14-in. cylinder running 150 r. p.m. This oil was used for years without any trouble from lubrication, valve leakage or carbon deposits.

The oil representative made his regular calls on us, and each time we told him what we were doing; but he assured us we were on the wrong track and that sooner or later would get into trouble. After continued tests, however, and careful observation of all conditions, we became satisfied that the latter oil is the most suitable for air-cylinder lubrication when working against a 100-lb. pressure, with either single- or two-stage compression.

AN OLD FRIEND CALLS

One day an old friend of mine called, who also happened to be an expert representing one of the leading oil companies. I related to him my experience with air-cylinder lubrication and, somewhat to my surprise, he too assured me that we were using the wrong oil and said, "You know you get not less than 400 deg. C. F. in your air cylinder when working against 100 lb., single stage." With this I agreed. I then asked him how he knew we were wrong, and what means he employed for ascertaining the proper grade of oil for air-cylinder lubrication. He then proceeded to explain the method his company's engineers use in determining the proper oil for different kinds of service.

He explained this in part:

"You have agreed that the temperature of the air is 400 deg. Our test would be conducted as follows: Take a block of cast iron 6 or 8 in. square and 2 in. thick, place this block on a layer of sand in a shallow iron pan and pack the sand closely around the cast-iron block, then put a gas burner under the pan and turn on the heat slowly. The top surface of this block is polished and is provided with a drilled hole into which a thermometer is inserted. Heavy steam-cylinder oil is poured into the hole around the thermometer bulb so as to make a close heat contact. When the thermometer rises to 400 deg., lower your gas burner until the thermometer remains steady at this temperature. Then take your different samples, dip the point of a lead pencil into the oil, hold the pencil 2 in. from the surface of this iron block and allow a drop to fall on the hot polished surface.

When such a test is made with the grade of oil from which you say you are getting successful results, we find the drop spreads out to about 1⅛ in. in diameter, smokes a little, dries up, and is evaporated in ten seconds time, leaving the surface perfectly dry. With a higher grade of oil having a flash point of 450 deg. F. and heavy viscosity, when the drop falls on the surface of this polished block it spreads out to about 1¼ in. in diameter, smokes a little, but after five minutes the surface is still oily. Thus we have proof that this is the proper oil to withstand such service as you get in your air-compressor cylinder.

Then I asked him what he thought the temperature of the surface of the cylinder wall was when the air in the cylinder was at 400 deg. F. He hesitated a little, then said he believed it would be about 25 deg. F. less than the temperature of the air. I disagreed with him here, saying this did not seem right, as the water-jacketed wall should be much cooler than the air. After some discussion we went into the office and consulted some authorities on the subject; we found some tests had been made abroad on the temperature of the cylinder walls in an internal combustion engine, where, with an explosion temperature of 2700 deg. F. and an average temperature through the cycle of 950 deg. F., and the water in the jacket at 200 deg. F., the inside surface of the cylinder wall did not go above 267 deg. F.

When my friend was shown these figures he was nearly speechless, and admitted that he had never thought that the temperature of the wall of an internal combustion engine cylinder, with an explosion temperature so high, could remain as cool as this authority stated. However, since the character of the authority was such that it could not be questioned, it was accepted by the oil expert. I then asked what he thought the temperature of the air cylinder wall should be when the air does not exceed 400 deg. F., in answer to which he said he did not know, but did not believe it would be much above the temperature of the water in the jacket.

As a matter of fact, the temperature of the inside of a water-jacketed cylinder wall is not more than 30 deg. F. higher than the temperature of the jacket water, as long as the water does not boil; and, since this is the true condition, what is the use in employing oils of low gravity, high fire test and high viscosity to meet a condition such as this? The temperature of the inside surface of the cylinder wall on an air compressor is little, if any, above the temperature of the surface in the main bearing of the ordinary Corliss engine.

HIGH VISCOSITY IS NOT ESSENTIAL

From this it appears that the ordinary oil expert who lays much stress on high viscosity and high flash point has not considered the true conditions. Furthermore, it has been shown in this article that the cause of carbon deposits in the passages of an air cylinder is not always entirely chargeable to the residuum of oil, but in many instances is due to using a lubricant of too heavy a body, which ad-

heres to the passages of the cylinder. Also, when the inlet is not properly protected from foreign matter, all such material as coal dust, fine ashes, shavings, waste, etc., is drawn into the cylinder and deposited on the sticky surfaces coated with this heavy oil. This foreign matter, with additional oil, gradually builds up until the passages become choked. The air valves now begin to leak for some reason, thus increasing the temperature, until finally this sometimes reaches a point as high as 500 deg. F. when compressing to 100 lb. single stage. If there are many shavings or much coal dust deposited in the passages, this is apt to char and become incandescent. When this takes place the temperature of the air rises rapidly, and as a consequence the pressure increases quickly to a point beyond the strength of the receiver, and results in what is generally called an explosion.

It is my opinion that no violent explosion ever takes place in the ordinary air compressor, unless kerosene, gasoline or some such material is introduced into the compression.

In my personal experience some years ago with a two-stage compressor where the intake had been neglected and also the wrong grade and quantity of oil had been used, the high-pressure discharge valves became leaky, thus allowing the air to churn in and out of the cylinder at each stroke, and heating it until it became so hot that the heavy deposits in the passages actually took fire; the whole system burned out, like a chimney from an old-time wood stove. Fortunately, however, there was no explosion because the safety valve on the receiver relieved the sudden pressure caused by the burning material in the discharge passages and the compressor was promptly shut down.

From the foregoing it will be understood that in the selection of an oil for air-cylinder lubrication, nothing should be used but a pure mineral product having a gravity of from 31 to 33 Beaumé, a flash point of 375 to 390 deg. F., and a viscosity of 140 to 150 S at 100 deg. F. Under no circumstances should a heavy grade be used, despite whatever claims may be made by the oil salesmen as to the virtues of heavy viscosities or high flash points. It should also be borne in mind that when the surface of the cylinder wall is once glazed over, little oil is required to properly and adequately lubricate the working surfaces.

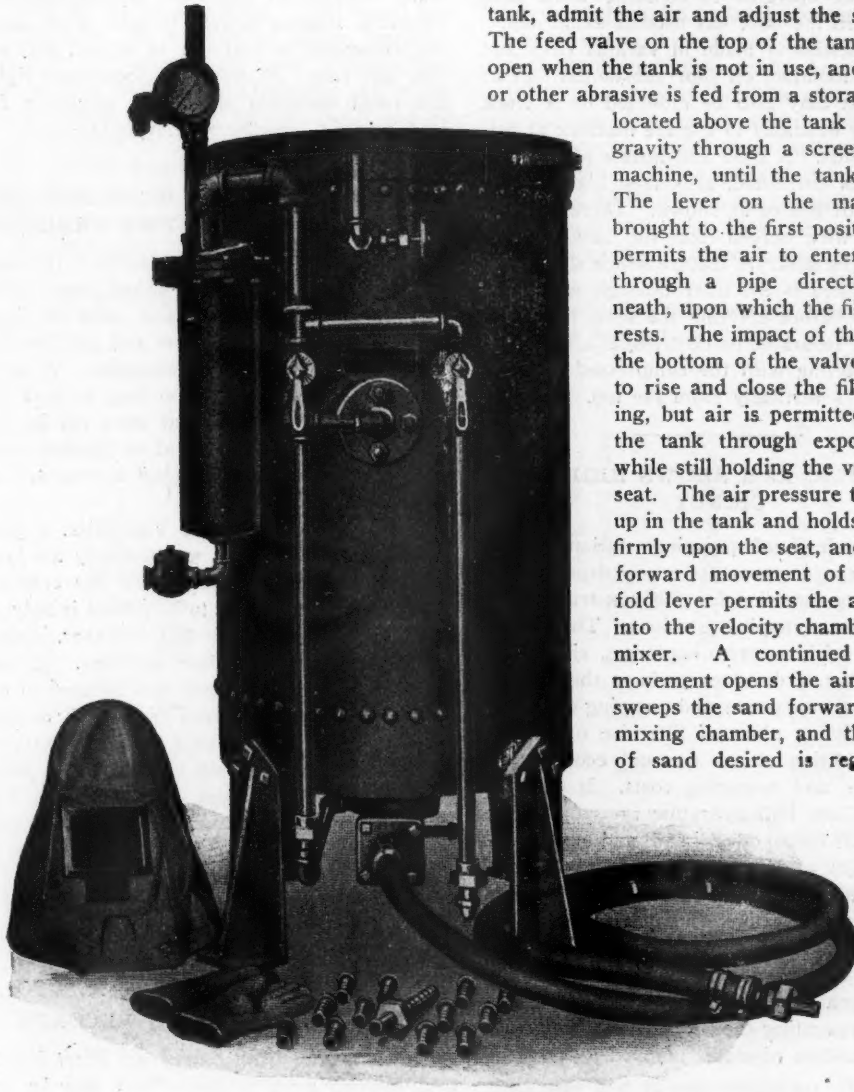
TOO MUCH OIL FORMS CARBON DEPOSIT

The film of oil on the cylinder wall is understood to be less than 0.00025 in. in thickness. The piston rides back and forth on this film, which requires little oil to be added in order to maintain the necessary quantity. Should a greater amount of oil be used than just enough to keep up the required film, it will be plowed up ahead of the piston and be forced through the valves and into the cylinder cavities, where it will collect in the low places and solidify by reason of being mixed with foreign matter taken in through the inlet. This forms deposits commonly called carbon.

As has been shown, a 14x14-in. cylinder can be adequately lubricated with two drops of oil per minute when the compressor is operated at 150 r.p.m. This is the equivalent of one drop of oil for each 800 sq. ft. of cylinder surface swept by the piston. The oil herein referred to happened to be made from a paraffin base petroleum. However, it is believed that an oil of about the same consistency, refined from an asphalt base natural oil would serve as well, if not better.—*Coal Age.*

AUTOMATIC POSITIVE PRESSURE SAND BLAST APPARATUS

The illustration herewith shows the essential features of the positive pressure sand blast apparatus made by The W. W. Sly Manufacturing Company, Cleveland, Ohio. With an unfailing supply of sand and of air the continuous operation of the machine is automatically provided for. The body of the machine is a sand tank with the mixing chamber under the lower head. This mixing chamber has a plate upon which the sand is fed from the tank by passing through an inverted taper sleeve, this sleeve being relied upon to prevent any obstruction from entering the mixing chamber which would not subsequently pass through the lip of the hose. The sand discharged by the feed sleeve upon the sand plate is wiped forward by air from an adjustable air port and by this means the flow of sand is controlled. The air passing this port is divided by a deflector so that the walls, which otherwise would be subjected to the action of the sand, may be protected by a bank of clean air, the sand being nibbled away by that portion of the air that is thrown forward toward the center. The velocity of the air passing over



and reverse, but this is sufficient to fill the tank, admit the air and adjust the sand feed. The feed valve on the top of the tank remains open when the tank is not in use, and the sand or other abrasive is fed from a storage hopper located above the tank falling by gravity through a screen into the machine, until the tank is filled. The lever on the manifold is brought to the first position which permits the air to enter the tank through a pipe directly underneath, upon which the filling valve rests. The impact of the air upon the bottom of the valve causes it to rise and close the filling opening, but air is permitted to enter the tank through exposed ports while still holding the valve on its seat. The air pressure then builds up in the tank and holds the valve firmly upon the seat, and the next forward movement of the manifold lever permits the air to flow into the velocity chamber of the mixer. A continued forward movement opens the air port and sweeps the sand forward into the mixing chamber, and the amount of sand desired is regulated by

the plate is only sufficient to wipe the proper amount of sand foward to a point just below the entrance to the hose, where it is picked up and shot forward by the high velocity air. This arrangement eliminates wear in the mixing chamber.

The operation of the tank is controlled by a specially designed manifold valve located on the side of the machine in a convenient position for the operator. The valve has only one lever and one progressive movement, forward

the progressive forward movement of the lever. The volume of blasting air remains constant while the valve lever is being moved. If the sand flow becomes impeded for any reason, a forward movement of the valve lever beyond the point of maximum sand supply to the hose and nozzle releases the air in the tank and reverses the flow up through the bottom. This is relied upon to break down any bank or remove the obstruction from the top of the feed sleeve, thus per-

mitting the operator to continue work until the sand in the tank has become exhausted.

The machine is made in various sizes and generally mounted on four substantial legs as shown. It may also be mounted on a truck when it is desirable to use the machine at different points. A hose and nozzle of the best material is furnished, also sand blast helmet and pair of gloves as shown. There is a removable wire screen for the sand before charging the tank. A feature which should not be overlooked is the filter through which the air passes before entering the tank, the moisture being separated by centrifugal action. The pipe connecting with the compressed air supply projects vertically from the top.

HYDRAULIC RAM SHOWS HIGH EFFICIENCY

The Maple Leaf pumping station of the City of Seattle represents a new departure in the common practice for the construction of water-power pumping stations. This plant should be of interest to engineers, since it is believed that it develops perhaps the highest known combined power and pumping efficiency of any existing plant of like size or larger, and in addition shows unusual economy in installation and operating costs. It consists of two 12-inch Hill hydraulic rams operating under a 50-foot power head and against a pumping lift of 140 feet from a point above the rams to the full tank level. Performance tests showed a range of capacity of water pumped from 720,000 to 1,300,000 gallons per day with corresponding efficiencies of from 90.8 per cent. to about 85 per cent. The normal daily operating capacity is something over 1,000,000 gallons of water pumped.

Eventually the plant capacity will take care of some 28,000 population and furnish ample fire protection for the 790 acres involved. The rams are simple in operation. They are started with an auxiliary starting valve, and adjustment for capacity is made by turning an adjusting screw up or down. All mechanical movement is limited to simple valve shifts of small motion, and as all moving parts are inside the machines, in water, no oil is used or required. The rams operate continuously in the locked gate house and inspection is made only once or twice a week by the regular water department employee. Maintenance and renewals, limited largely to new valve seats, are estimated to cost not to exceed $10 per year per ram. As wear is exceedingly light, the rams maintain their full efficiency for long periods.—*Engineering News-Record.*

TOO LONG AND TOO WIDE FOR THE LOCKS, BUT SHE MUST GO THROUGH

When the United States entered the war 190 vessels on the Great Lakes were taken over by the Government and most of them have been taken to tidewater and put into the carrying of munitions and supplies. A large number of these vessels too long to pass the locks of the Welland Canal were cut in two and after reaching Montreal or Quebec were welded together again as good as new and at once put in service.

One ship, however, the Van Hise, a 9000 ton dead weight carrier, was not only too long but was also 50 ft. wide, while the extreme width limit of the locks to be passed is only 44 ft. Such a little thing as that, however, is simple enough to the modern engineer. It was found that when the deck was cleared of all superstructure the distance from deck to keel was only 25 ft. So the only thing necessary to do after the ship was cut in two was to place each half on her beam ends and run her through in that position, and that at the present writing is being done. A pontoon is provided to lie along under the side of the keel and the trim of the floating body is then easily adjusted by controlling the volume of air and water within the pontoon.

BONA FIDE RIVETING RECORDS

The following from *Emergency Fleet News*, a publication more or less official, may be accepted without question. The figures given are very different from some which have been circulated in the daily papers.

"Believing that everlasting team work is the most result-producing in the long run, Edw. G. McCulloch, superintendent of the Newport News Shipbuilding & Drydock Company, is trying to encourage riveters in that company's yards to drive an average of 400 'pegs' a day, considering that a fair day's work.

"In carrying out the idea a blackboard has been erected in the yard, upon which are

chalked daily, statistics showing exactly what the various gangs are doing. This board has columns for the number of gangs working, rivets driven, average per gang, average that should have been made, gangs out, and rivets lost by gangs out. All sizes of rivets and all kinds of work are taken into consideration by J. H. Lofland, assistant superintendent of hull construction, in placing 400 rivets as a first-class gang average for nine hours. For June 13 the blackboard stood as follows:"

It Will Take About 75,000 Rivets Every Working Day to Give to "Uncle Sam" the Ships We Are Expected to Build This Year.

See below what YOU are doing.

Date—	No. Gangs In	Rivets Driven	Average Per Gang	Avg. We Should Have	Gangs Out	Rivets Lost by Gangs Out
June 3rd	156	53,288	342	400	21	7,182
June 4th	154	50,492	328	400	31	10,168
June 5th	167	62,381	374	400	20	7,480
June 6th	168	55,477	330	400	17	5,610
June 7th	169	54,985	325	400	21	6,825
June 8th	146	32,301	442	400	38	16,796
		308,924				54,061

Saturday, June 8th, was half-holiday.

June 4th.	No. 16930, Powell	drove 1217	on Hull No.	225.
June 5th.	No. 16958, Crawford	" 1400	" " "	224.
June 6th.	No. 16893, Johnson	" 1541	" " "	225.
June 6th.	No. 16906, Poarch	" 1648	" " "	225.
June 10th.	No. 16873, Price	" 2100	" " "	224.

Experiments carried out in Germany show that the inner tube of pneumatic tires keeps its elasticity for a long time when lying in a solution of 10 per cent. glycerine and 1 per cent. soda in water.

LOCATING ENEMY GUNS IN FRANCE*

No wonder the French called their engineers "Genie," thinking of the "Arabian Nights" and the genie that came out of the vase and accomplished all those wonders. They are the perfection of mathematicians. They have figured out the influence of the earth on a shell traveling out of the cannon; how much father it will shoot north than south; how much the height of the moon deflects the shot, and what is called the ultimate error of the cannon shot is disappearing under their mathematics. If a commander cannot point a cannon within ten feet of the shot he is not counted a success.

Somebody asked me how they located the guns and whether by aeroplanes. I said, "Not alone. There are three ways of doing it—spot flashing, sound ranging, and then the aeroplane to check both up." The most uncanny thing is sound ranging; it is shooting around the corner, surely. They have a very delicately devised wire that is heated red hot, and so sensitive that if you blow your breath on it it goes out. They put up six or eight of these wires at different points, all connected by electricity back to the central station, and then have a moving-picture machine. When an enemy gun goes off a button is pushed and the moving-picture machine goes into action, and as the vibration of that gun reaches each one of these stations there is a little quiver in the line that is printed on that film, and

*From an address by Maj. Gen. Charles M. Clement, U. S. A., before the Philadelphia Association of Members of the American Society of Mechanical Engineers.

when it comes out it is handed over to the officer, and he goes to a carefully calculated table and proceeds to locate that gun by the vibrations taken miles away from where the recording instrument was, transmitted underground by wires buried six feet and brought back to this little encasement of his and printed; and those little strips of paper come back and locate the gun that fired that shot. Then he proves it by spot flashing, and as the sound travels from one place to another a number of people push a button, and, knowing that sound travels so many meters a minute, they prepare a map on which to locate it. Because paper expands and contracts, they make the map of zinc and they cut the paper in two-inch squares, so that nothing in accuracy shall be lost by the expansion or contraction of the paper under heat and dampness. They have a parabola around it with everything calculated, and stretch six strings around that, and when the six strings get over the same spot there is the gun, and when the other six strings get over there they are sure it is there, and then they get the airman to fly over it, and he can see if they are right, and it is nine out of ten if they drop a shot over there that that gun goes out of business.

No Middle Ground for Loyalty.

By H. E. NEGLEY, Indianapolis, Ind.

When Nations stand at grips of death, amidst the Battle's pall;
When Valiant Soldiers pray for aid, and Suffering Peoples call;
When Hate and Crime usurp the place of Human Virtues grand;
There isn't any Middle Ground where Loyalty may stand.

When Fear and Famine stalk abroad, like Monsters of the night;
When Mothers, horror-stricken, weep at War's appalling sight;
When Innocence is common prey, and Murder foully planned;
There isn't any Middle Ground where Loyalty may stand.

When Virtue falls like broken reed, and Famished Children moan:
When Mercy leaves the human breast, and Malice reigns alone;
When breaking hearts beat unison in every martyred land;
There isn't any Middle Ground where Loyalty may stand.

When Reason on her broken throne, gives way to Lust and Greed;
When Avarice, with Power mad, makes helpless nations bleed;
When Passion, with its iron rule, is riding in command;
There isn't any Middle Ground where Loyalty may stand.

When Nation's Manhood marches forth to cope with Craven Foe;
When Womanhood gives up its all, and freely bids them go;
When Sacrifice exacts its toll, from us on every hand;
There isn't any Middle Ground where Loyalty may stand.

When Honor bids the nations arm, and save the Human Race;
When Treason from her slimy lair begins to show her face;
When Patriotism only stands against her Brigand Band;
There isn't any Middle Ground where Loyalty may stand.

Manufacturer's Record.

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EVERYTHING PNEUMATIC
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CONTENTS

MONEY, MEN, SHIPS

Nothing of which history tells was ever sprung upon the world with more crashing suddenness than the war which is upon us. No greater task was ever laid upon a nation than that we shoulder now. Concentered upon us is the hope and the trust of the world, and without us none dares think what must have been the ultimate result.

This supreme, compelling, self-saving, world-saving, all absorbing business, which was not of our choosing but which we must perforce accept, is getting well under way with phenomenal unanimity of impulse and with unwavering confidence as to the outcome. The call is for all our strength and resource without the wasting of a day. Nothing that can obstruct or delay is for a moment to be allowed. We have no time to waste to talk of terms of peace or of what is to be done when the belching fires of hell shall have been quenched. The only thing to think of and to work for is to end the war, and in the only way possible that it should be ended.

The imperative call is for money, men, ships, and it is not easy to say which of these in our thoughts should precede the other, for each is indispensable. The money and the men we need not speak of here, for both being ready at hand could lavishly and promptly respond to the call.

With the ships the story is different, for they had all to be built; and the rush of the building speaks the momentum of the national purpose. Of old the building of ships was a slow and tedious process; now we do in a month what was the work of years. We are building ships of steel, of wood and of concrete, in old shipyards and in new, on both the great oceans and in the Gulf, all making records of achievement unthought of until actually accomplished.

The story of Hog Island shipyard when it can be written in full, we may well believe will have more incomparable things in it than any other. Think of the size of it, 900 acres, or the area of New York City from the Battery up to Cooper Institute or Wanamakers. And then, to begin with, the only requisite it had was waterfront. The ground was more swamp than anything else and had to be "made," so at once we have pile driving records, and records also of the collecting and depositing of

material. Not only was the actual building of the ships to be provided for but there was also the catering to all the modern wants of the army of workmen. The total cost of the yard will amount to $50,000,000 and there are already placed with it contracts for the building of ships to the amount of $200,000,000. Five months, less one day, after the awarding of the contract actual shipbuilding was begun, the launchings are already frequent, and when the plant is in full swing a ship will be taking the water about every other day.

The completed shipyard will comprise 50 shipways and 7 outfitting piers, each of the latter handling four ships at once. The operations involved in the building of these ships are now entirely accomplished by mechanical means and very little old fashioned handwork finds place. The entire mechanical equipment would make a long list, electricity of course being the responsible power distributor. In the actual details of the working compressed air figures most largely, a brief enumeration of this installation being given elsewhere in our present issue. There are 17 large air compressors with an aggregate free air capacity of about 75,000 cu. ft. per min. There are many miles of air distributing pipes and 300,000 feet of rubber hose. This air is used to actuate about 2,500 pneumatic riveters of different sizes, 800 pneumatic drills and 1,800 pneumatic hammers, with all their various appurtenances.

It is scarcely possible to avoid speaking of the one Hog Island record which seems to be unique. The entire air compressing and air actuated equipment is supplied by a single manufacturing firm.

AERONAUTICAL INVENTIONS AND SUGGESTIONS

[The following compiled by *The Engineer*, London, for the benefit of English suggesters and would-be inventors, should be of equal value to a class not less numerous or less prolific in the United States.]

We are informed by the Air Ministry that the Air Inventions Committee, which was formed about nine months ago, has now received and examined upwards of 5000 inventions and suggestions relating to the Air Service. It is regretted that, owing to war conditions, a detailed account of the Committee's investigations cannot be published, but the following statement will, it is hoped, facilitate the work, both of inventors and of the Committee. It is realized that the information given is incomplete. It is appreciated also that inventors are placed at great disadvantages in present circumstances, for, unless immediately connected either with the Air Service or with aircraft manufacture, it is almost impossible that they should be acquainted with the most recent developments. So rapid has been the recent rate of progress that it is difficult, even for those in close contact with the Royal Air Force, to keep abreast of all the latest improvements.

LITTLE CHANCE FOR REVOLUTIONARY INVENTIONS

It may be noted in the first place that it is practically useless for inventors at the present time to submit inventions which would necessarily take a long period to develop; the requirements of war and the conditions of labor and material make it impossible for the Committee to support proposals of this nature. Generally speaking, and, as far as the period of the war is concerned, no very startling change in the present type of aircraft is anticipated, although improvements in parts and also in details are always possible, and may produce very important results.

The stage of development in construction which has now been reached is such that major improvements can only be expected from those possessing the requisite scientific and mechanical knowledge, skill and experience. Thus, radical changes in the shape of the wings of aeroplanes, the body, and the propellers are only possible after long and patient research carried out in aeronautical laboratories. Again, many inventors have forwarded proposals for helicopters aircraft of a similar nature, which, if an efficient design could be produced, would possess certain advantages—but probably not to the extent at one time imagined. Others have suggested flapping wings and rotary planes. Such schemes do not give any promise of being capable of development for use during this war, and, in any case, would require some years of experiment before they could be regarded as practical proposals.

As regards minor improvements, inventors should bear in mind that many details, such as turnbuckles, clips, etc., are now standardized, and that a change would only be justified by some very marked superiority. Safety devices for the machine and the pilot form a numer-

ous class among the ideas submitted. The chief means suggested is the parachute, either applied by a harness to the pilot or directly attached to the machine. Those who have seen a passenger dropped by parachute from an aeroplane for exhibition purposes often fail to realize the conditions under which a parachute may have to be used as a safety appliance. The machine may be out of control, dropping at a velocity of 150 to 200 miles per hour, or spinning downwards in flames. Many other safety devices such as automatic stabilizers, wind brakes, etc., have been proposed at various times. The additional weight incurred by the use of any of the suggested safety appliances must remain a very serious factor so long as war conditions prevail.

ENGINE REQUIREMENTS

The engine is the heart of the aeroplane, and on its reliability depends the safety of the pilot. People acquainted only with motor car engine practice sometimes do not realize the exacting conditions under which an aeroplane engine must work. The engine has to be capable of running for the whole of the time of flight at its maximum power. The lubrication and ignition must be perfect, and the engine must not become overheated. The rating applied to aeroplane engines is its weight per horse-power, and engines are now being produced which show surprising results in this respect. Inventions which differ radically from present day practice—such as the internal-combustion turbine—have small possibilities of being adopted, for successive design and reconstruction entailing probably several years' work are necessary before satisfactory results can be expected. In view of the shortages of material and labor at the present time, no new type can be embarked on unless it is demonstrably superior to existing types, and possessed of definite and immediate advantages over them.

NOISE OF THE MACHINE

A subject intimately connected with the power plant is its noise. This noise constitutes one of the disadvantages of an aeroplane. For night flying a method by which it would be possible to hear from one aeroplane the approach of another would be of great advantage. The engine can be silenced without serious disadvantages, but the noise of the propeller and the hum of the wires are so great that silencing the engine is not sufficient to achieve the object in view.

Many proposals for the projection of bombs and grenades, of flame, and of poisonous gases have been received. The trailing bomb or grapnel for attacking enemy aircraft and submarines is a favorite suggestion from inventors. This device was tested before the war, and at various times since, but has been abandoned in favor of more effective methods.

Many hundreds of inventions and suggestions for inclinometers and instruments for straight flying and accurate bomb-dropping have been investigated. Efficient and well-designed instruments for these purposes have been available for some time past, but it is quite possible that improved forms may still be produced, though it is scarcely likely that this can be done by anyone who does not possess the scientific and mechanical knowledge required for an investigation of the nature involved. Some inventors of aeronautical instruments entirely disregard the action of centrifugal force upon pendulum and spirit level devices. Many gyroscopic instruments have been proposed which show the inventors to possess insufficient knowledge of the correct application and limitations of a gyroscope.

Anti-aircraft devices of various kinds are constantly being suggested, but the suggestions now contain very little new matter for consideration, and for the most part have received the careful attention of the authorities for a long time past, and have been the subject of much trial and experiment.

Any proposals of a practical nature which contain features of novelty and may be of utility are discussed with the assistance of the Air Service. The Committee fully appreciates the genuinely patriotic motives which inspire most of the communications which it has received, and it is with the object of encouraging the submission of useful and well-considered proposals that the information contained in this statement is issued for publication. Inventors should, however, bear in mind that the somewhat obvious proposals which might have been useful in an earlier stage of the war are now no longer serviceable. By following the

general tenor of the above suggestions, inventors will greatly assist the Committee in the execution of its responsible duties.

MINES AND COUNTERMINES IN THE TRENCHES

By Capt. H. D. Trounce*

Our work in the Flanders trenches was almost entirely confined to mining. As soon as the Germans had been halted in their drive in August, 1914, they entrenched themselves, and wherever the trenches of the Allies were within 100 yards of their own they proceeded to start mining across "No Man's Land." Early in 1915 they exploded a large number of mines underneath the Allied trenches. The French and British immediately organized tunneling or mining companies and proceeded to countermine. During 1915 they were mostly engaged on the defensive in these operations below ground, but toward the end of 1915 and in 1916 and 1917 the Allies succeeded in reversing the state of affairs and were active with offensive mining.

When I reached the trenches early in the first week of January, 1916, the British company I was with had succeeded in sinking a number of shafts (not, however, without having several of them destroyed by the enemy during their construction) and had driven a number of galleries well over toward the Hun lines. Our trenches here opposite Fromelles averaged from 80 to 150 yards apart. On account of shallow water level, we averaged a depth of about 25 ft. below the surface, and only by constant pumping with hand pumps were we able to keep up the progress in our galleries. The soil was generally a blue plastic clay. At intervals we would strike running sand, and when this happened we usually found it wise to abandon the drive and start new workings. At the outset many of our tunnels also were destroyed by enemy "blows," but we succeeded in putting in quite an elaborate system in the course of time. The sector we were operating on had a frontage of approximately half a mile, and on this front we had about 16 shafts. From the shafts we drove a complete system of defensive galleries. Our main galleries were about 5½ ft. by 2½ to 3 ft. in cross section; branch galleries about 4½ ft. by 2½ ft. and with listening galleries or "rabbit holes," were usually in the form of a Y from the end of branch galleries and these were used principally for listening purposes.

ENEMY EASILY DETECTED IN CHALK OR FLINT

There is a marked difference between mining in clay and chalk. Later on in the Vimy Ridge area we had considerable mining in chalk. In clay it was possible for the Germans and ourselves to tunnel to within a few feet of each other before we could hear any sound of mining; and elaborate precautions were taken to insure silence. In chalk it is possible to hear from much longer distances, especially where the chalk contained any amount of flint.

To insure silent working in the clay we would use grafting tools instead of shovels. No nails were used in the timbering, all sets being wedged with sand bags. Blankets were hung in the end of galleries to deaden the noise. As we approach nearer to the enemy, the men working in advanced tunnels would have to use canvas shoes or work in their socks. No talking was allowed. Every precaution was taken to insure silent work. As the life of every one in the galleries depended on this, the work was conducted almost noiselessly. When we reached within striking distance of the enemy, we would build a charge chamber and load it with gun-cotton, connecting up with detonators and a double set of leads to the charge, and at the right moment fire these charges from the trench above by means of blasting machines. From this clay soil and at a depth of from 20 to 25 ft., we would blow craters 60 or 70 ft. wide with a small charge of 600 or 700 lbs. of guncotton. As a matter of fact, when we met the Hun below ground under "No Man's Land" we would endeavor to fire "camouflets," that is, a charge calculated to destroy enemy galleries but not to break the surface of the ground. We would usually carry on our work until we heard the Germans talking. When you can hear the enemy talking in clay you can bet they are pretty close. On some occasions we have in this way fired our mines when within three or four feet of enemy mines. In March, 1916, we broke into a German gallery and had a fight with them underground.

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*From *The Castle* published at Camp A. A. Humphreys, Virginia.

MINING AT DEPTH OF 150 FEET

Trench mining in clay is much more dangerous than in chalk, on account of the fact I have mentioned—the difficulty of hearing operations until one is almost on top of them. In the chalk country further south, in the Vimy Ridge trenches and the Somme area, we were mining at much greater depths. Some of our mines were 150 ft. deep, and after the battle of the Somme we found the Germans at Fricourt had a mine system 200 ft. deep. For these chalk mines we used a different and much stronger high explosive than guncotton. With the British, we used individual mine charges as large as 100,000 lb. These would blow cone-shaped craters several hundred feet in diameter and well over 100 ft. deep. Some idea of the terrific force of these mines can be obtained when you compare the bursting charge of the Mills bomb, which contains 4 oz., or 1/4 lb., of ammonal, with the single mine charges of 100,000 lb., or 400,000 times that amount. You cannot see a hand bomb, like the Mills, burst without having some respect for its destructive qualities—particularly if you are close up.

Nearly all of our work on these Flanders mines was done by hand. At times our galleries and tunnels would be half full of water, and it required constant pumping, day and night, to carry on the operations. Hand water pumps and hand air pumps were used. Vertical shafts were sunk in this clay, usually of case timber, and light pit-prop sets were used for the galleries. All the dirt was handled in sand bags from the face, and brought out from the main galleries on rubber-tired mine cars and hoisted to the surface by windlasses. The sand bags were used for reveting and repairing trenches, which are being continually destroyed by enemy fire and action of the weather, and the surplus bags were emptied at night into shell holes and old mine craters.

We were fortunate, in our work below ground in not losing more men than we did, but it required constant and careful listening to avoid casualties. We could distinguish in time the nature of the sounds of the enemy miners when charging their mines, as distinct from everyday work, and mighty useful it was that we could do so. When we suspected the enemy were about to fire one of their mines, we would warn the infantry and have them withdraw any of their men who were on guard on top at threatened points. Sometimes they would keep us guessing, and would hold their mines, just as we did ours, for several days or even a week or two before firing them. The fact that mining is going on between the trenches is easily established after several weeks work, but every effort is made to conceal the exact location of the galleries.

LUBRICATION OF AIR COMPRESSORS

My experience with air compressors, which isn't a great deal, is that they require less oil (but a mighty good oil) than any other power plant machinery.

In the lubrication of an air compressor of more than one stage, I feed most of the oil to the first stage, very little to the second, and if it has three stages the third gets practically none.

The reason I do this is because the heat generated by the compression of the air in the cylinder vaporizes the oil and it is carried from stage to stage and does all its work. In an air compressor you have not the wiping effect on cylinder walls as in a steam cylinder, consequently less oil will do; but you must have a good oil and use it rightly. I tell by the condition of my valves how things are going. If they are dry or the least bit gummy, I give her a little more, and if they have an oil film that will penetrate two cigarette papers I leave her alone.

Above all things, do not clean your high pressure compressor with either gasoline or kerosene. Use bicarbonate of soda or soda water or soap suds. Feed this freely through the lubricator and follow with oil, making sure everything is getting oil before shutting down on account of leaving moisture in cylinders and valves while standing. Do this every two or three months. Bleed your air bottles and pipes for moisture. But get a good oil and use it judiciously. I have an 8 and 5 and 2 3/8 by 8, three-stage compressor for fuel injector in a Diesel engine, which takes 2 qt. of good oil in two weeks, running 24 hours a day and 7 days a week. But no two will lubricate alike. Oil your air compressor independently from the rest of your engine and do not try to use reclaimed or filtered oil from either it or other machinery.—*Jack Stein in Power Plant Engineering.*

GASES USED BY THE HUNS

Major S. J. M. Auld in the Journal of the Washington Academy of Sciences, gives the following list of gases used by the Germans:

1. Allyl isothiocyanate (allyl mustard oil) C_3H_5NCS (shell).
2. Benzyl bromide, $C_6H_5CH_2Br$ (shell).
3. Bromaceton, $CH_2Br.CO.CH_3$ (hand grenades).
4. Bromated methyl ethyl ketone (bromketone), $CH_2Br.CO.C_2H_5$ or $CH_3CO.CHBr.CH_3$ (shell). Dibromketone, $CH_2.CO.CHBr.CH_2Br$. (shell).
5. Bromine, Br_2 (hand grenades).
6. Chloracetone, $CH_2Cl.CO.CH_3$ (hand grenades).
7. Chlorine, Cl_2 (cloud).
8. Chlormethyl chloroformate (palite), Cl $COOCH_2Cl$ (shell).
9. Nitrotrichlormethane (chloropicrin or nitrochloroform), CCl_3NO_2 (shell).
10. Chlorosulphonic acid, $SO_3H.Cl$ (hand grenades and "smoke pots").
11. Dichlordiethylsulphide (mustard gas), $(CH_2ClCH_2)_2S$ (shell).
12. Dimethyl sulphate, $(CH_3)_2SD_4$ (hand grenades).
13. Diphenylchlorarsine, $(C_6H_5)_2AsCl$ (shell).
14. Dichlormethyl ether, $(CH_2Cl)_2$ (shell).
15. Methylchlorosulphonate, CH_3ClSO_3 (hand grenades).
16. Phenylcarbylamine chloride, $C_6H_5NCCl_2$ (shell).
17. Phosgene (carbonyl chloride), $COCl_2$ (cloud and shell).
18. Sulphur trioxide, SO_3 (hand grenades and shell).
19. Trichlormethylchloroformate (diphosgene, superpalite), $ClCOCCl_3$ (shell).
20. Xylyl bromide (tolyl bromide), $CH_3C_6H_4$ CH_2Br (shell).

JACKHAMERS IN SOUTH AFRICAN MINES

In the annual report of the Robinson Deep mine, Transvaal, South Africa, the manager, J. J. Wessels, stated that during the year an improved method of stoping was evolved by the adoption of the jackhamer machine. Its use has resulted in a saving of native labor, and it is more economical in explosives than the reciprocating machine. The results for the six months ended Dec. 31, 1917, when an average of 28.5 jackhamers were in continuous use for stoping, show that the average fathomage per jackhamer was 12.4% higher than that of the reciprocating machine, the latter using approximately 100% more labor per machine shift and 86% more explosives per fathom broken. The reciprocating machine used 102% and the jackhamer only 9% more explosives per fathom than was employed in breaking rock by hand labor. During the period each jackhamer, employed an average of 1.25 natives, did the equivalent fathomage of seven hammer boys, so that the replacement by jackhamers of the 37,000 to 62,000 hammer boys employed at the Witwatersrand mines at various periods would save for other work a large percentage of the present native labor force. Dust tests showed that stopes operated by the jackhamer (which cannot be worked without water) and stopes operated by hand labor were about equal, though the stopes where the reciprocating machines were used were about 100% higher in mineral dust.

NOTES

The alternating current crane has one inherent safety feature not found in the crane with direct current motors, in that the motor is built with a predetermined fixed torque, and a heavier load than this maximum torque will handle cannot be lifted, whereas, with the series wound direct current motor, there is no limit to the load it will attempt to lift, and if excessively overloaded the motor will burn out provided some part of the hoisting mechanism does not fail.

Concrete depends for its strength upon securing the highest possible density. With a given aggregate and the same quantity of cement the strength of the concrete reaches its maximum with the smallest quantity of water that can be used to produce a plastic mix. Any increase in the amount of water is accompanied by a rapid decrease in the strength of the concrete.

Seemingly empty gasoline cans or tanks are probably more dangerous than those filled with gasoline. Usually the can is not entirely emptied, the remaining gasoline will vaporize, the vapor will mix with the air in the can, and the mixture may easily be explosive. When the can is being filled, this mixture is forced out

by the gasoline and may explode if ignited by a flame or spark near the opening.

An interferometer is an instrument that makes use of the optical properties of gases, and is suitable for analyzing a binary gas mixture.

Remaining on the wing continuously for 30 hours and 30 minutes is the latest feat recorded in the world of aviation. This record as reported by the Navy Department at Washington, on August 2, was made by Ensign P. J. Barnes, who is attached to the American Naval Air Forces in European waters.

According to the U. S. Geological Survey, more sulphuric acid was produced in the United States in 1917 than in any previous year. A moderate estimate shows that the increase in the production of acid of all strengths in 1917 over that in 1916, stated in terms of 60-deg. B. acid, amounted to at least 600,000 tons.

What is said to be the largest hydraulic turbine so far built, or under construction, is to be installed by the Hydraulic Power Co., Niagara Falls. The normal operating conditions for which the turbine has been designed are as follows: Heads from 213 to 214 ft.; speed 150 r.p.m.; discharge, 1500 cu.ft. per second; capacity, 37,500 hp. It will be installed in the extension of the above-named company's Station No. 3.

Dyes developed at the chemical laboratory of the Rensselaer Polytechnic Institute, Troy, N. Y., are now being used by some of the big clothing concerns of the country. Since the German supplies of dyestuffs were cut off the chemists at the R. P. I. laboratory have been experimenting with different colors, and, it is said, have turned out many dyes, which, upon being tested, have proven the equal, if not the superior, of any dyestuffs imported from Germany before the war.

A unique method of loading hay into railway cars has been developed at Hermiston, Ore. The load is backed up against a deck or float beside the car, and the crane lifts the alfalfa from the wagon to this deck. A man then feeds into the cutting machine with a pitchfork, and a blower, propelled by gasoline engine, hurls the hay into the car. This machinery not only eliminates considerable human labor and saves time, but packs the hay probably better than a man could pack it with a fork. The blower is made on the same principle as the "cyclone" straw stacker used on grain threshers and gives the same satisfaction in use.—*Scientific American.*

The use of compressed air for transporting concrete for tunnel lining has ceased to attract attention because of its novelty. Now the air conveying process is being applied to other classes of concrete work. For example, P. J. Joyce & Co., of New York, contractors for the masonry work involved in the B. & O. grade separation project at Pittsburgh, have used the air method in building concrete retaining walls. A central plant was used to mix and force the concrete a maximum distance of 1,500 ft. through an 8-in. pipe, using air at 80 to 100 lb. pressure. The concrete was first shot into a receiving hopper, carried on a traveler that straddled the wall, and thence was delivered by gravity through a flexible pipe into the Blaw steel forms which were also carried by the traveler.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 11

1,268,816. COMPRESSED-AIR JACK. Warren J. Buchner and Raymond F. North, Glendive, Mont.

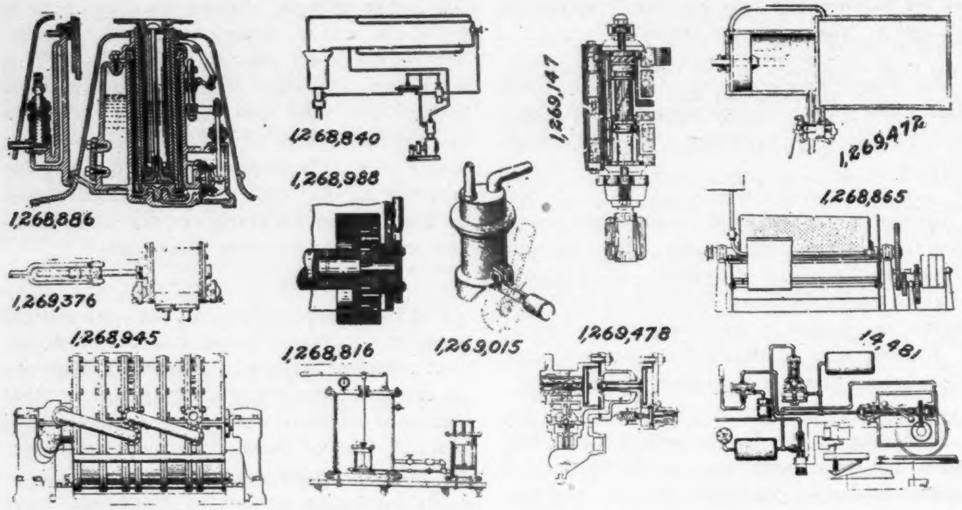
1,268,840. GAS-COMPRESSION PLANT. Arthur Heane, Blayney, New South Wales, Australia.

1,268,865. PROCESS FOR PRESSING YEAST. Ejnar Alfred Meyer, Clifton, Bristol, England.

1. A process of pressing yeast, consisting in depositing yeast in liquid form upon the surface of a revolving drum, then exhausting air from the drum to solidify the yeast on the drum, and then removing the relatively dry outer layer of the deposited yeast leaving a relatively damp layer on the drum to prevent the breaking of a vacuum within the drum.

1,268,886. CHAIR. Adolph W. Schramm, Riverton, N. J.

1. In an adjustable chair, supporting means for the seat of the chair, a fluid chamber, a pressure supply for placing a fluid in said chamber under pressure to actuate the chair seat supporting means, a valve controlling



PNEUMATIC PATENTS JUNE 11

said pressure supply, ports for the passage of the fluid, valves controlling said ports, operating means for said first and second named valves, and means operating automatically to center said operating means and to cause the said last-named valves to close off their ports simultaneously.

1,268,945. TURBINE-MOTOR FOR USE WITH COMPRESSED AIR. Gustaf Engelbrekt, Superior, Wis.

1,268,988. VACUUM-CLEANER. Francis C. Mason, Grand Rapids, Mich.

1,269,015. MILKING-MACHINE. Emil Starch and Benjamin Starch, La Crosse, Wis.

1,269,147. PERCUSSIVE ROCK-DRILLING APPARATUS. Richard Henry Adams, Cobalt, Ontario, Canada.

1,269,376. VACUUM-PUMP. Lionel Bull, Libertyville, Ill.

1,269,407. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, East Syracuse, N. Y.

1,269,472. FLUID-PRESSURE BRAKE. Richard H. McGeary, Allegheny, Pa.

1,269,478. FLUID-PRESSURE BRAKE SYSTEM. Frank L. Marston, Portland, Me.

1,269,535. ELASTIC-FLUID ENGINE. Reginald F. Halliwell, Rugby, England.

1. The combination with an engine adapted to be operated by low pressure elastic fluid, of a valve mechanism for controlling the flow of such elastic fluid, and regulating means for the valve mechanism comprising means responsive to the speed of the engine, and means responsive to the pressure of the low pressure elastic fluid, and a manually operable device for moving the valve mechanism independently of said regulating means, whereby the effective action of the regulating means on the valve mechanism may be varied.

1,269,540. ELASTIC-FLUID TURBINE. Fredrik Ljungstrom, Stockholm, Sweden.

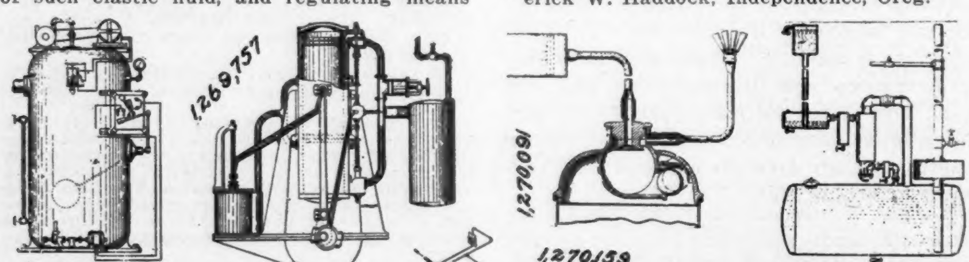
14,481 (Reissue). SPEED-CONTROLLING APPARATUS FOR RAILWAY-VEHICLES. Lloyd V. Lewis, Edgewood borough, Pa.

1. Controlling apparatus for vehicles comprising a centrifugal device operatively connected with an axle of a vehicle, fluid pressure on the vehicle acting in opposition to the centrifugal device, means on the vehicle for permitting a gradual reduction of fluid pressure in accordance with lapse of time, and means controlled by the centrifugal device when the latter overcomes the said fluid pressure for controlling the vehicle.

JUNE 18

1,269,697. AUTOMATIC VACUUM-MAINTAINING APPARATUS. Claude A. Flinn, Battle Creek, Mich.

1,269,704. ORE-SEPARATING DEVICE. Roderick W. Haddock, Independence, Oreg.



PNEUMATIC PATENTS JUNE 18

1. In an ore separating device, the combination of a main piping, a plurality of sectional short pipings positioned in the same plane as the main piping, said short piping being substantially parallel, U shaped elbows connected to the ends of said short piping, tubular members carried upon said short piping, short pipes connected to said tubular members, said short pipes extending at right-angles to each other, thus causing abrupt abutments for the particles of ore being drawn through said piping and pipes by air, so as to cause the minerals to be readily deposited in said tubular members.

1,269,739. FLUID-PUMP Lewis A. Payton, Haskew, Okla.

1,269,757. APPARATUS FOR PROPORTIONING THE CHARGE OF FUEL AND AIR IN INTERNAL-COMBUSTION ENGINES. Lyman S. Stevens, Baltimore, Md.

JUNE 25

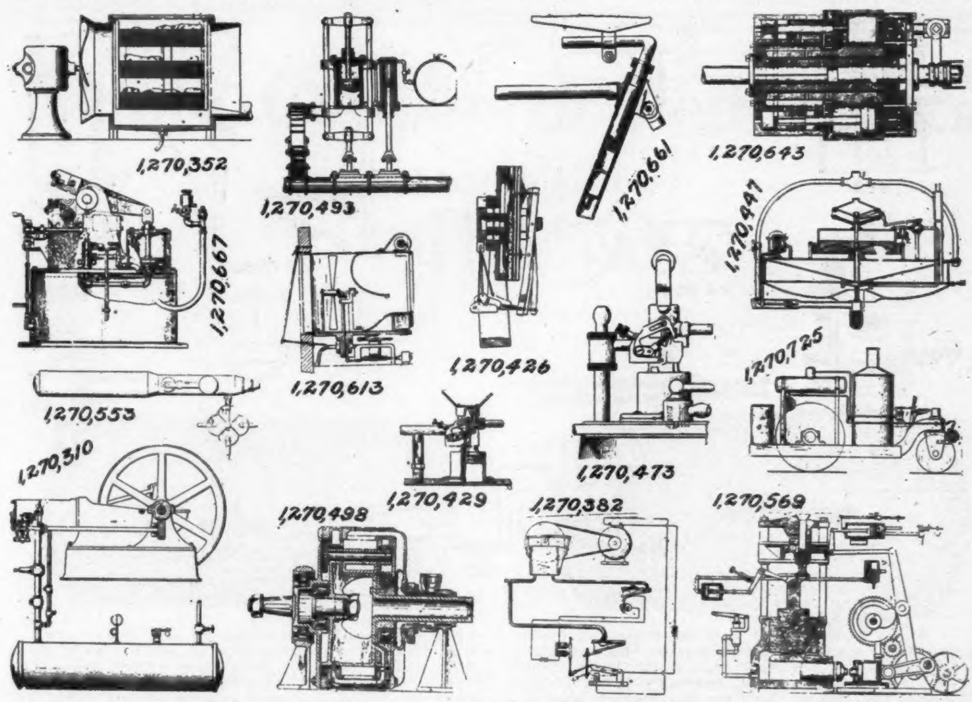
1,270,310. APPARATUS FOR COMPRESSING ELASTIC FLUIDS. Milton McWhorter, Playas, N. Mex.

1,270,352. VENTILATING AND COOLING APPARATUS. James A. Williams, Roxbury, Mass.

1,270,382. AUTOMATIC CONTROLLING DEVICE FOR THE MOTORS OF PNEUMATICS. John A. Weser, New York, N. Y.; Elsie L. Weser, administratrix of said John A. Weser, deceased.

1,270,426. PNEUMATIC MOTOR. Frank G. Lynde, Newark, N. J.

1,270,429. PULSATOR FOR MILKING-MACHINES. Arthur Chichester Macartney, Bloomfield, N. J.



PNEUMATIC PATENTS JUNE 25

1,269,931. METHOD OF DRYING VARNISHED PATENT-LEATHER. Ernest Hintz, Wiesbaden, Germany.

1. Method of drying varnished (patent) leather and the like consisting in exposing the material to be dried under exclusion of all atmospheric air or other oxidizing agent to the action of light of short wave length and rich in ultraviolet rays.

1,270,091. MILKINK-MACHINE. George V. Andrew, Harvard, Ill.

1,270,135. STATIONARY CHEMICAL-MIXING FIRE-EXTINGUISHER SYSTEM. John W. Enright, New Orleans, La.

1,270,159. AUTOMATIC CONTROL FOR HUMIDIFYING APPARATUS. William B. Hodge, Charlotte, N. C.

1. In a humidifying system, a source of pressure supply, a distributing line for said pressure supply, and means for exhausting the working pressure in the line simultaneously with the shutting off of the main pressure from said source.

1,270,447. APPARATUS FOR COMPRESSING GAS OR AIR. Charles Scott-Snell, Ridgway, Wimbledon, England.

1,270,473. PULSATOR FOR MILKING-MACHINES. Robert Warnock, Bloomfield, N. J.

1,270,493. VEHICLE AIR-CUSHION COMPRESSOR. John J. Campodonico, Stockton, Cal.

1,270,498. ROTARY ENGINE PUMP, COMPRESSOR AND THE LIKE. Bruce Conklin, London, England.

1,270,553. AIR-BRUSH. John Rouge, New York, N. Y.

1,270,569. PRESS. Preston Upham, Boston, Mass.

1,270,613. VENTILATOR AND AIR-PURIFYING APPARATUS. Frank A. Gustavson, Seekonk, Mass.

1,270,643. FLUID TRANSMISSION. Mark H. Massuere, Cheyenne, Wyo.

1,270,661. PNEUMATIC SADDLE-POST AND PUMP. Lowerre B. Reed, Rutherford, N. J.

1,270,667. ROCK-DRILL SHARPENER. William A. Smith, Denver, Colo.
1,270,725. STREET-ROLLER. John Gratton, San Francisco, Cal.

JULY 2

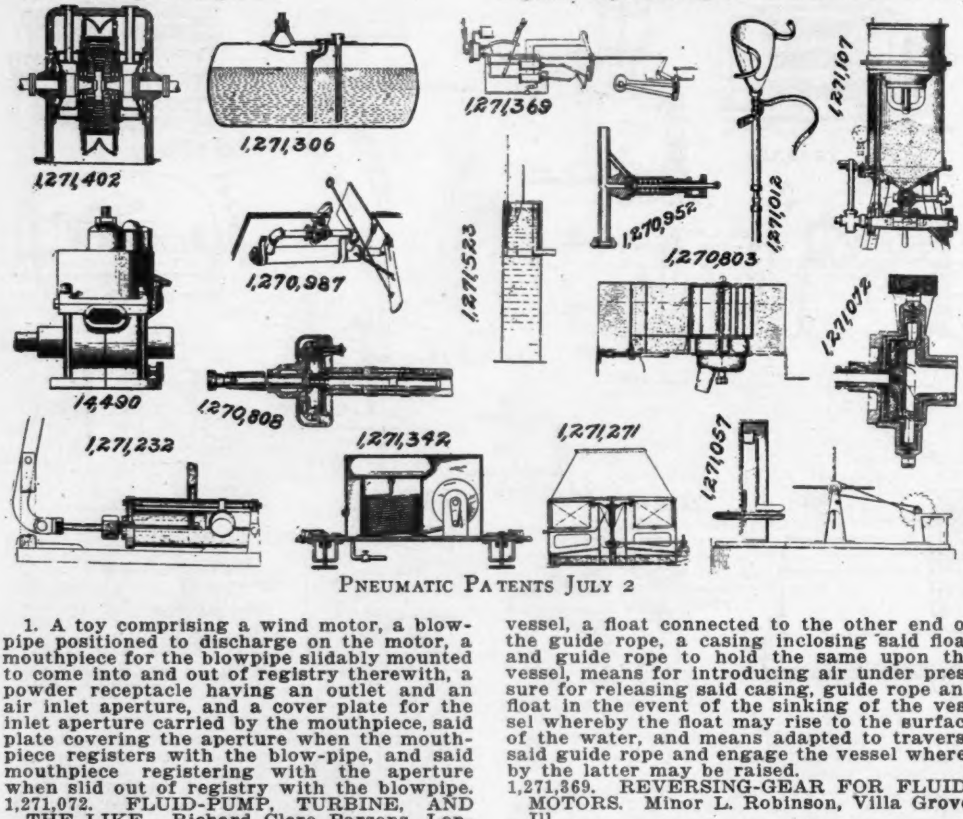
1,270,803. WINDMOTOR. William F. Folmer, Rochester, N. Y.
1,270,808. ROTARY TOOL. Charles H. Franklin, Schenectady, N. Y.
1,270,952. TIRE-PRESSURE VALVE AND SIGNAL. Guerdon O. Jones, Bouton, Iowa.
1,270,987. FLUID-CONTROLLED SWITCH-OPERATING MECHANISM. John Bell Stroud, Pass Christian, Miss.
1,271,012. BREATHING AND FACE-PROTECTING APPARATUS FOR ROCK-DRILLS. Aime Blanc, Aspen, Colo.
1,271,057. TRICK TOY. Henry Millhouse, Chicago, Ill., assignor of one-half to George Victor Lillig, Chicago, Ill.

1,271,197. MINING-MACHINE. Edmund C. Morgan, New York, N. Y.

1. In a mining machine, a main frame, a reciprocating mining tool mounted thereon for universal movement, and means for actuating said mining tool, in combination with fluid-pressure power-actuated mechanism for advancing and anchoring said main frame.

1,271,232. AIR-PUMP. George Scriver, Creemore, Ontario, Canada.
1,271,271. APPARATUS FOR COOLING, HUMIDIFYING, AND FILTERING AIR OR THE LIKE. Henry Francis Brown, Sheffield, England.
1,271,306. AIR-MOISTENING DEVICE. David J. Fox, Boston, Mass.
1,271,342. APPARATUS FOR RAISING SUNKEN VESSELS. John W. MacDonald, Portsmouth, Va.

1. In apparatus for raising sunken vessels, a guide rope having one end secured to the



PNEUMATIC PATENTS JULY 2

1. A toy comprising a wind motor, a blowpipe positioned to discharge on the motor, a mouthpiece for the blowpipe slidably mounted to come into and out of registry therewith, a powder receptacle having an outlet and an air inlet aperture, and a cover plate for the inlet aperture carried by the mouthpiece, said plate covering the aperture when the mouthpiece registers with the blow-pipe, and said mouthpiece registering with the aperture when slid out of registry with the blowpipe.

1,271,072. FLUID-PUMP, TURBINE, AND THE LIKE. Richard Clere Parsons, London, England.
1,271,107. SPRAYING APPARATUS. Carl Weller, Zurich, Switzerland.

1. A spraying apparatus, such as a sandblast machine, white-washing or painting sprayer and the like, comprising a spraying material tank, a compressed air feed-pipe, a mixing-pipe connected to said feed-pipe, means provided with a passage for the spraying material and adjustably arranged between the material tank and the mixing pipe, a member removably secured to the spraying apparatus and a cleaning-pipe.

1,271,188. PNEUMATIC ACTION. Frank G. Lynde, Newark, N. J.
1,271,193. PNEUMATIC ACTION FOR PLAYER-PIANOS. Harry Meyer, Wellston, Mo.

vessel, a float connected to the other end of the guide rope, a casing inclosing said float and guide rope to hold the same upon the vessel, means for introducing air under pressure for releasing said casing, guide rope and float in the event of the sinking of the vessel whereby the float may rise to the surface of the water, and means adapted to traverse said guide rope and engage the vessel whereby the latter may be raised.

1,271,369. REVERSING-GEAR FOR FLUID-MOTORS. Minor L. Robinson, Villa Grove, Ill.
1,271,402. ELASTIC-FLUID TURBINE. Oskar Anton Wiberg, Finspong, Sweden.
1,271,523. APPARATUS FOR MEASURING THE QUANTITY OF EXPIRED AIR. Haydn Brown, Chislehurst, England.
14,490 (Reissue). FLUID-PUMP. George W. Kellogg, Rochester, N. Y.

1. In a pump, the combination with a base having an oil chamber located therein, of a cylinder arranged on the base, a piston reciprocating in the cylinder, and a baffle located at the bottom of the cylinder to prevent oil splash from the oil chamber to the cylinder walls but adapted to receive oil on its upper surface, whereby efficient lubrication is provided and excessive lubrication prevented.